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Revisions to the Phase I Interim Report and Phase II Proposal

**CIBA-GEIGY Facility
Cranston, Rhode Island**

Volume 1 of 2

Submitted by:

CIBA-GEIGY Corporation

444 Sawmill River Road
Ardsley, New York 10502

July 1993



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PREFACE

This document presents revisions to the Phase I Interim Report and Phase II Proposal (submitted in November 1991) for the RCRA Facility Investigation of the CIBA-GEIGY facility at Cranston, RI. These revisions address comments received from the USEPA in a letter dated 15 June 1993, and fulfill the conditions for approval of the Phase I Interim Report and Phase II Proposal.

Organization of This Document

This document has two volumes (binders); each volume has specific tabs (indexed dividers) corresponding to the chapter/appendix revised.

Volume 1, Revisions and Addendum for the Phase I Interim Report and Phase II Proposal, includes revisions to Chapters 3, 4, 6, 7, 8, 11, 14, 15, 16, and 17, as well as revisions to Appendix B. Some of these revisions are presented on revised (replacement) pages, tables, and/or figures. Others of these revisions are presented in the Addendum (new Appendix BB). Note that Chapters 11 and 16 have been replaced in their entirety. The tabs in Volume 1 are:

- *Chapter 3* — contains revised Figure 3-6.
- *Chapter 4* — contains various revised tables and figures.
- *Chapter 6* — contains revised page 6-11 and Table 6-3.
- *Chapter 11* — replaces the original version of Chapter 11.
- *Chapter 15* — contains revised Table 15-2.
- *Chapter 16* — replaces the original version of Chapter 16.
- *Chapter 17* — contains revised pages 17-8, 17-9, 17-14, and 17-18.
- *Appendix B* — contains revised Tables B-7, B-8, and B-9.
- *Appendix BB* — an Addendum which contains specific discussions about the migration of constituents and why additional investigation of the deep overburden groundwater and bedrock aquifer is unnecessary (addressing Comments 2, 3, 12, 14, 15, 28, and 29).

Volume 2, Revised Data for the Phase I Interim Report and Phase II Proposal, includes replacements of the data appendices requiring revision based on the USEPA comments. The tabs in Volume 2 are:

- *Appendix V* — replaces the original version of the Phase IB Analytical Data.
- *Appendix W* — replaces the original version of the Rejections in the Phase IB Analytical Data.
- *Appendix X* — replaces the original version of the Indicator and Reference Data.
- *Appendix AA* — a new appendix contains the data for the Detection Limit Evaluation.

Note that two of the comments from the USEPA, numbers 42 and 57 in the approval letter, were addressed in a letter recently submitted to the USEPA (and are not addressed further in this document).

Key to Comments/Revisions

The following table summarizes how and where each of the USEPA comments are addressed.

Comment Number(s)	Topic (Brief Description)	Addressed in/by	Found in	
			Volume	Tab
1	Value for piezometer P-19D	Revised Figure 3-6	1	3
2	Migration of constituents/additional investigation not needed	Addendum	1	BB
3	Migration of constituents/additional investigation not needed	Addendum	1	BB
4	Explain codes for "method of development"	Revised Table 4-2	1	4
5	Storativity values	Stabilization Investigation data table	—	—
6	Indicate dates and numerical data points	Revised figures (as needed)	1	4
7	Stratigraphy should be added	Revised figures (as needed)	1	4
8	Value for RW-1 inconsistent	Revised Figure 4-2	1	4
9	Several errors	Revised Figure 4-6	1	4
10	<i>(As suggested in the USEPA approval letter, this comment will be addressed in the <u>RFI Report</u>.)</i>		—	—
11	Summary table has inconsistent value	Revised page 6-11	1	6
12	Migration of constituents/additional investigation not needed	Addendum	1	BB
13	Mercury level not highlighted	Revised Table 6-3	1	6
14	Migration of constituents/additional investigation not needed	Addendum	1	BB
15	Migration of constituents/additional investigation not needed	Addendum	1	BB
16	<i>(As suggested in the USEPA approval letter, this comment will be addressed in the <u>RFI Report</u>.)</i>		—	—
17	Re-evaluate Belmont Park location	Revised Chapter 16 entirely	1	16
18 – 26	(Various comments on Chapter 11)	Revised Chapter 11 entirely	1	11
27	<i>(As suggested in the USEPA approval letter, this comment will be addressed in the <u>RFI Report</u>.)</i>		—	—
28	Migration of constituents/additional investigation not needed	Addendum	1	BB
29	Migration of constituents/additional investigation not needed	Addendum	1	BB
30	Well MW-32S not included	Revised Table 15-2	1	15
31 – 35	(Various comments on Chapter 16)	Revised Chapter 16 entirely	1	16
36	Chemical/electrochemical precipitation	Revised page 17-8 (and 17-9)	1	17
37	Biological treatment of soils	Revised page 17-14	1	17
38	Biological treatment of groundwater	(no change needed to page 17-16)	—	—
39	Water/solvent leaching	Revised page 17-18	1	17
40	Data qualifiers NR and U not included	Revised Table B-7	1	B
41	Final data should show estimated value	Revised Table B-9 (and Table B-8)	1	B
42	Request not to do downhole logging (Appendix U)	Letter submitted to USEPA already	—	—
43	Errors in Appendix V; key to data needed	Revised Appendix V entirely	2	V
44	Explain codes; rejections in data base; add a column	Revised Appendix W entirely	2	W
45 – 56	(Various comments on Appendix X)	Revised Appendix X entirely	2	X
57	Request not to do groundwater flow modeling (Appendix Y)	Letter submitted to USEPA already	—	—

TECHNICAL REVIEW - PHASE I INTERIM REPORT AND PHASE II PROPOSAL

CHAPTER 3 - PHASE I GEOLOGICAL INVESTIGATION

1. **Figure 3-6:** Either the value for piezometer P-19D (-41.90 feet) or the contours in this area appear to be incorrect. This should be corrected.

The elevation for piezometer P-19D (-41.90) was incorrect. The correct elevation (-14.4) is shown in revised Figure 3-6.

CHAPTER 4 - PHASE I HYDROGEOLOGICAL INVESTIGATION

2. **Page 4-6:** The discussion of the till states that it appears to act as an aquitard, however, because the till is discontinuous there is some potential for good hydraulic connection between the two aquifers where the till is absent. There should be more discussion on the areas where the till is absent and whether these areas are a concern due to possible migration of overburden aquifer contaminants.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

3. **Fig. 4-7 & Table 4-4:** Chapter 4 states that there is little or no potential for the bedrock aquifer to become contaminated because an upward gradient exists. However, a slight downward gradient appears to exist at well cluster MW-11S, MW-6S, P-18D, and RW-3 all in the SWMU 5 area. There should be a more thorough discussion of the characteristics and the relationship between the aquifers and the gradients.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

4. **Table 4-2:** A footnote which explains the codes used for "method of development" should be provided.

Table 4-2 was revised to include a footnote describing the development methods for piezometers and monitoring wells.

5. **Table 4-3:** Storativity values should be listed on this table.

The recovery tests performed in Phase I were short in duration. Because short-duration tests can yield inaccurate storativity values, these values were not calculated. Longer-term aquifer tests were performed during the Stabilization Investigation. Storativity values were calculated using these long-term test data. These values are included the Stabilization Investigation Report and Design Concepts Proposal (Table 2-13).

6. **All Figures:** All figures should indicate the date for which the water levels represent and have the numerical data points on the figure.

Water level data and the dates these measurements were taken have been added to revised Figures 4-3 and 4-5.

7. The stratigraphy should be added since flow lines and equipotentials should refract across hydraulic conductivity boundaries (such as the clay unit).

As discussed with USEPA, the site's stratigraphy was updated using new data collected during the Stabilization Investigation. A flow diagram which incorporates the site's new stratigraphic data has been developed. This flow diagram is included in the Stabilization Investigation Report and Design Concepts Proposal (Figure 2-14).

8. **Figure 4-2:** The value for RW-1 (9.17 feet) does not agree with the value shown on table 4-4. This should be corrected.

The elevation for bedrock well RW-1 was mislabelled. The correct elevation is shown in revised Figure 4-2.

9. **Figure 4-6:** This cross section has several errors. The wells/piezometers P-14S, P-14D, MW-10S, MW-10D, P-13S, P-6M are not located in the same place where they are portrayed in plan view maps. It appears that the wells may be incorrectly labeled making the trace of this cross section unreasonable for making flow interpretations, since it is constructed along a sharp bend. This should be corrected.

The errors on this figure have been corrected (see revised Figure 4-6).

CHAPTER 6 - PHASE I RELEASE CHARACTERIZATION: PRODUCTION AREA

10. The Phase I Interim Report and Phase II Proposal attempts to present a reduced version of the analytical data by using summary tables which display the data in several different ways. This first appears in Chapter 6 and then throughout the rest of the document. In developing these tables certain assumptions are made and statistical parameters are met. EPA questions the picture these assumptions and statistical parameters present and would like to amend and approve their use in any summary tables prior to inclusion in the RFI Report. For the record, EPA questions the method of selecting the "Baseline Concentrations", the calculation of the "Mean Total Concentration" and the presentation of the "# of analytes detected".

This issue will be addressed with USEPA prior to the development of the RFI Report.

11. **Page 6-11:** The soil summary table indicates a maximum VOC hit of 9.4 ppm. Table 6-2 shows a maximum hit of 33 ppm at B-3A. These tables should be corrected.

The concentration of VOCs (9.4 ppm) in the soil summary table (on page 6-11) was incorrect. Page 6-11 has been revised to include the correct concentration (33 ppm).

12. **Page 6-28:** A more thorough discussion should be given on why additional sampling of Bedrock well RW-1 will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

13. **Table 6-3:** The mercury level at B-11C exceeded the background soil range but was not highlighted. Is this concentration correct?

The mercury concentration of the soil sampled from boring B-11C did exceed the range of background concentrations. Table 6-3 was revised to highlight this exceedance.

CHAPTER 7 - PHASE I RELEASE CHARACTERIZATION: W.W. TREATMENT AREA

14. **Page 7-13&14:** A more thorough discussion should be given on why additional sampling of wells RW-2 and MW-15D will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

CHAPTER 8 - PHASE I RELEASE CHARACTERIZATION: WARWICK AREA

15. **Page 8-8&17:** A more thorough discussion should be given on why additional sampling of wells RW-3 and MW-17D will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

CHAPTER 10 - PHASE I OFF-SITE INVESTIGATION

16. There should be more discussion on published background concentrations for soils.

This issue will be addressed with USEPA prior to developing the RFI Report.

17. **Page 10-4:** The metals and PAH's identified at Belmont Park may be indicative of non-background conditions (contaminated fill may have been deposited here). This location will have to be reevaluated to determine its appropriateness as a background soil location or some statistical method to weight this outlier will have to be agreed upon.

As agreed with USEPA, Belmont Park will be resampled as a background location in Phase II (see comment No.32).

CHAPTER 11 - SELECTION OF INDICATOR COMPOUNDS

18. **General:** The CSF for 1,2-Dichloropropane should be changed to 6.8×10^{-2} which comes directly from HEAST. This number and all calculations using this number should be corrected.

The CSF for 1,2-dichloropropane has been revised to 6.8×10^{-2} (mg/kg-day)⁻¹ in Table X-44 and all calculations.

19. Region I policy, until HQ develops policy or values, for PAH oral route exposure is, for non-carcinogens, to use verified reference doses or, if unavailable, the reference dose of 4×10^{-3} mg/kg-day for naphthalene.

The reference dose for naphthalene, rather than pyrene, is used for all noncarcinogenic PAHs without published toxicity values. This change is reflected in Table X-44 and all calculations.

20. **Page 11-5:** A discussion on transport between media should be included.

The discussion of transport between media has been expanded in Section 11.2.4.

21. **Page 11-11:** The first paragraph refers to RCRA-Recommended Levels in the proposed Subpart S Rule. These are examples offered in the proposed rule and Region I does not advocate their use since many are outdated. IRIS and HEAST should be used for performing the dose response section.

The text was misleading. IRIS and HEAST were used as the primary references for toxicity values, not the RCRA proposed Subpart S Rule. The text in Section 11.4.2 has been revised to clarify this.

22. Region I does not agree with or approve of the splitting of risk levels based on carcinogenic classification as stated in the third paragraph. All carcinogens should be treated the same for this screening process and a risk level of 1×10^{-6} should be used.

The target risk level (ILCR) for class C carcinogens has been changed from 1×10^{-5} to 1×10^{-6} in the calculation of risk-based screening levels presented in Tables X-45 and X-46. The text in Section 11.4.2 has been revised to reflect this change.

23. **Page 11-12:** The Case 2 discussion states that the 26 analytes with minimum detection limits above the estimated risk based levels are to be included in Phase II analysis. In order for this scenario not to occur once again in Phase II, the detection limits must be reduced to the risk based levels.

This issue has been addressed with USEPA (see revised Section 11.4.3).

24. **Page 11-13:** The analysis for the Case 3 analytes as described in the 1st paragraph should be provided.

The "SWMU-by-SWMU" analysis of detection limits has been added. The data are presented in Appendix AA.

25. The detection limits described in the 2nd bullet should be addressed.

Detection limits are addressed in the QAPP for Phase II studies. Every attempt will be made to reach the lowest detection limits feasible for dioxins and furans in Phase II.

26. The values described in the 4th bullet for the six chemicals should be identified or a discussion on how these compounds will be addressed should be provided since these compounds were found in soil/sediment as shown in Appendix X-44.

An expanded discussion of detections and detection limits for the seven semivolatile compounds in question has been added to Section 11.4.3. These compounds were not detected in soil or sediment in Phase I; Table X-44 includes all Phase I analytes whether detected or not.

CHAPTER 13 - INTRODUCTION TO THE PHASE II PROPOSAL

27. It should be noted that ground water samples from existing wells will also be used to assess seasonal variations in contaminants in addition to verification purposes. This should be stated in future reports.

This issue will be addressed in future reports submitted to USEPA.

CHAPTER 14 - PHASE II PHYSICAL CHARACTERIZATION PROPOSAL

28. There needs to be more discussion on why a deep well will not be needed in the southern portion of the WWT Area at the proposed location of MW-25S.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

CHAPTER 15 - PHASE II RELEASE CHARACTERIZATION PROPOSAL

29. There needs to be more discussion on the rationale for excluding sampling the deep ground water at SWMU-10 and SWMU-12.

This issue is addressed in the Addendum to the Phase I Interim Report and Phase II Proposal (included in Appendix BB).

30. **Table 15-2:** The well MW-32S was not included in this table.

Table 15-2 has been revised to include monitoring well MW-32S.

CHAPTER 16 - PHASE II OFF-SITE INVESTIGATION PROPOSAL

31. All tables and figures should be modified to reflect changes in sampling strategy.

Tables 16-1 and 16-2, and Figure 16-1 have been modified.

32. **Pages 16-3 & 4:** Rather than re-verifying all four background surficial soil locations, the investigation should re-verify the outlier location at Belmont Park and one other location, and select two new locations, if access is available, to further expand on the background investigation. The new locations should be approved by EPA prior to sampling.

As requested by USEPA, the sampling strategy proposed for the background investigation was revised. The requested changes are included in revised Chapter 16.

33. The background ground water study needs an additional shallow well located upgradient of the production area.

An additional shallow well (MW-35S) upgradient of the Production Area has been added to the background groundwater study (see revised text, tables, and figures).

34. **Page 16-6:** Round 1 of the additional off-site investigation should sample five new locations in addition to resampling the 11 Phase I locations identified in the Order. Some new locations which can be found on figure 10-5 are Roberts Circle, Lakewood area south and southeast of the facility, Pawtuxet Reservation east of facility and Warwick Avenue southeast of facility. Round 2 should sample all locations. All round 1 and round 2 samples should be analyzed for indicator compounds which are all compounds found on-site.

As requested by USEPA, the sampling strategy proposed for the background investigation was revised. The requested changes are included in revised Chapter 16.

35. The last paragraph should state that data comparison will include Phase I data as well as Phase II data.

The last paragraph (on p 16-6) was modified to include data from both the Phase I and Phase II Investigations (see revised page 16-6).

CHAPTER 17 - PRELIMINARY EVALUATION OF CORRECTIVE MEASURES

36. **Page 17-8:** Since current ground water data shows the presence of iron and manganese above 1 ppm, pretreatment for the removal of metals will be probable and chemical/electrochemical precipitation needs to be included in any pilot testing performed.

Page 17-8 (Implications for Treatability Studies) has been revised. This comment also has been addressed in the Stabilization Work Plan and the Stabilization Investigation Report and Design Concepts Proposal.

37. **Page 17-14:** More justification is needed for not retaining biological treatment of soils for further evaluation. The reason given is that it does not remove heavy metals, but vapor extraction also does not remove heavy metals and this technology is retained for further evaluation. In addition,

biological treatment is being retained for evaluation for other media of concern where metals are of possible concern.

Page 17-14 (Biological Treatment) has been revised. This technology is being retained for further consideration.

38. **Page 17-16:** Will insitu biological treatment of ground water be evaluated as well? This technology may be beneficial if the data listed in Table 17-3 indicates that biodegradation is occurring in the aquifer.

Biological treatment of groundwater is being retained for further consideration as stated on pages 17-16 and 17-18, and in Tables 17-8 and 17-9.

39. **Page 17-18:** Paragraph 2 states that "water/solvent leaching" technology is not retained for further evaluation but on page 17-14 it states that it is. This contradiction needs to be corrected.

Page 17-18 has been revised. Water/solvent leaching is being retained for further consideration.

APPENDIX B - DATA MANAGEMENT

40. **Table B-7:** The data qualifiers NR and U are not included in this (validated data) table.

These qualifiers have now been added to this table (see revised Table B-7).

41. **Table B-9:** If the validated data qualifier was a J, ND or U then the final data should show the estimated value or detection limit. All data qualifier issues should be corrected as discussed.

The changes requested by USEPA have been made (see revised Table B-9). Because ND is no longer a valid qualifier for final data, ND has been deleted from Table B-8.

APPENDIX U - DOWNHOLE GEOPHYSICAL LOGGING QA DOCUMENT

42. EPA is in agreement with Ciba-Geigy's request to not conduct this activity due to the information gathered during the Stabilization Investigation. For the record, a written request and justification as previously discussed, should be submitted as an addendum to the Phase I Interim Report and Phase II Proposal. This request will be approved upon receipt.

A letter has been sent to USEPA requesting (and justifying) not to perform the downhole geophysical logging proposed for the Phase II investigation.

APPENDIX V - PHASE IB ANALYTICAL DATA

43. A comparison of the raw data in Appendix V and the data summary tables in chapters 6 through 10 do not agree. Some analytes are missing from Appendix V and some hits are not included in the summary tables. If there are errors they should be corrected. Some form of key to the location of data in Appendix V should be included.

Analytical data have been resubmitted in the format specified by USEPA. These data are now final. (Raw data were submitted previously.) The final data included within this appendix are now consistent with the data tables presented in the release characterization chapters.

APPENDIX W - PHASE IB ANALYTICAL DATA - REJECTIONS

44. What do the codes signify in this table and how will rejected analytes be replaced in the data base. This should be explained in the intro to this Appendix. There should be a column that shows why the analytes were rejected.

Appendix W (Phase IB Analytical Data Rejections) has been resubmitted. A key indicating why the analytes were rejected has been added. An explanation of how rejected data will be replaced in the data base is presented on the cover sheet to this appendix.

APPENDIX X - INDICATOR AND REFERENCE DATA

45. **General:** Indicator compound and target compound tables should indicate why the compounds were selected.

Tables X-47 through X-76 have been revised to indicate the reasons why target and indicator chemicals were selected. The new Table X-77 follows the same revised format as Tables X-62 through X-76.

46. The titles of some tables are incorrect and should be corrected.

Titles of all Appendix X tables have been reviewed for consistency and revised as needed. "Indicator Chemicals" or "Target Chemicals" has been changed to "Identified and Detected Chemicals" in the titles of Tables X-1 through X-15.

47. **Table X-44:** RfD's were not included for carcinogens. EPA Region I risk guidance requires that possible noncarcinogenic effects of carcinogens be evaluated. All available RfD's for classified carcinogens should be listed.

RfDs have been added to Table X-44 for Class A and B carcinogens where available.

48. For the purpose of ranking chemicals for the selection of indicator compounds the Cadmium RfD 1×10^{-3} for food could be used for chemicals in soils and the Cadmium RfD 5×10^{-4} for water could be used for chemicals in ground water.

Table X-44 has been revised to present both the RfD for cadmium in food and the RfD for cadmium in water. The RfD for cadmium in food was used for evaluating chemicals in soil. As indicated in Table X-45, the detection limits for cadmium in water were compared to the MCL for cadmium rather than a calculated risk-based level.

49. The slope factor for 1,2-dichloropropane is 6.8×10^{-2} .

The CSF for 1,2-dichloropropane has been revised to 6.8×10^{-2} (mg/kg-day)⁻¹ in Table X-44 and all calculations.

50. The RfD's for Selenium and Silver are 5×10^{-3} .

The RfDs for selenium and silver have been revised in Table X-44 and all calculations.

51. An explanation as to why the inhalation slope factor for Trans-1,4-dichloro-2-butene was used for the oral exposure route should be included in this table.

A justification for use of the inhalation slope factor for trans-1,4-dichloro-2-butene has been added to Table X-44 and the text in Section 11.4.2.

52. EPA has no value for lead in soils and one should not be proposed. If levels are found below background then EPA may allow them to be eliminated. The ECAO has an interim value for cobalt that should be used.

Table X-44 and the text in Section 11.4.2 have been revised to indicate that no toxicity values are currently available for lead. No quantitative toxicity data are used in the evaluation of lead in Phase I results. Detection limits for lead in water have been compared to the MCL for lead (Table X-45) and detection limits for lead in soil have been compared to background concentrations of lead in off-site surface soil (Table X-46).

The RfD for cobalt is based on the most recently available information from ECAO and does not need to be changed, as per a phone conversation between P. Goetchius of IT and F. Battaglia of EPA Region I on June 24, 1993.

53. **Table X-45:** Footnote "c" should be described.

Footnote "c" refers to those chemicals that have a federal or consent order MCL. These values were used when available instead of calculated risk-based levels in Table X-45. The table has been revised to include the most recently available MCLs and to clearly define footnote "c".

54. **Tables X-62 to 76:** These tables are incomplete and should be completed (ex., the dioxin/furans and the fingerprint compounds are not listed).

Tables X-62 through X-76 have been revised to include all indicator chemicals in soil, sediment and surface water, including dioxins/furans and fingerprint compounds where

appropriate. Groundwater indicator chemicals are addressed under comment no. 55.

55. Some of the tics listed in section 11.3.4 on page 11-10 are not included in these tables (ex., 1,1-Biphenyl in Pawtuxet river water). These omissions should be corrected. These tables show organics in ground water for indicator chemicals as a small subset of Appendix IX when in fact many more organics should be included. This should be corrected.

The text in Section 11.3.4 and Tables X-62 through X-76 have been checked for consistency and revised where necessary.

Table X-77 has been added to present the list of Appendix IX analytes, which will be indicator chemicals for groundwater in all areas sampled in Phase II. Any TICS or fingerprint compounds detected in groundwater (and not included in Appendix IX) are listed in Tables X-62 through X-76.

56. **Table X-76:** This table incorrectly lists some indicator chemicals. This should be corrected.

Table X-76 has been checked for accuracy and revised where necessary. Case 2 chemicals are no longer included as indicator chemicals in surface water.

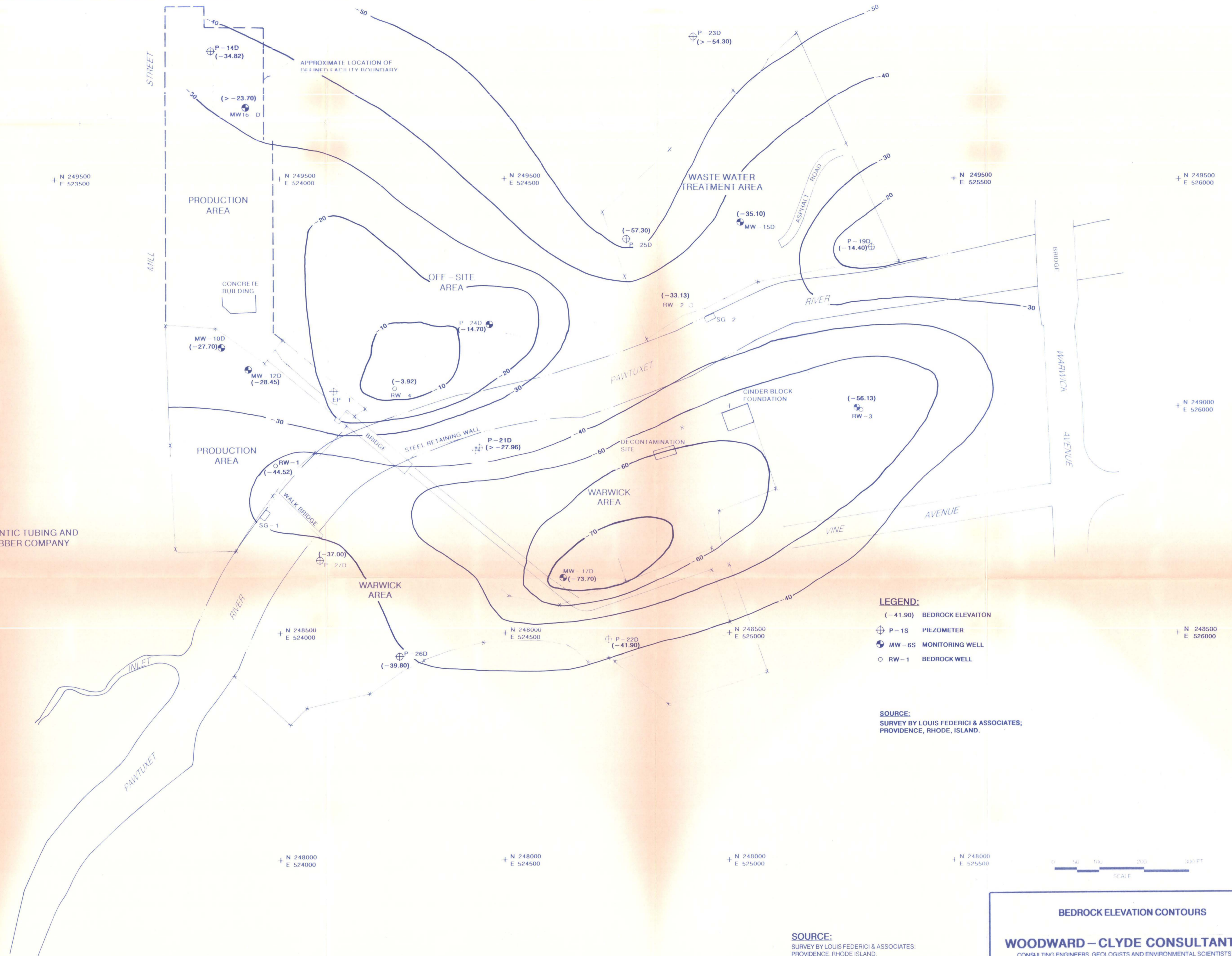
APPENDIX Y - PHASE II GROUND WATER FLOW MODELING

57. EPA is in agreement with Ciba-Geigy's request to not conduct this activity due to the information gathered during the Stabilization Investigation. For the record, a written request and justification as previously discussed, should be submitted as an addendum to the Phase I Interim Report and Phase II Proposal. This request will be approved upon receipt.

A letter has been sent to USEPA requesting (and justifying) not to perform the groundwater flow modeling proposed for the Phase II investigation.



ATLANTIC TUBING AND
RUBBER COMPANY



BEDROCK ELEVATION CONTOURS

WOODWARD - CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: 1:1200	PROJ. NO.: 87X4660
CK'D BY: JMD	DATE: 7 NOV 1991	FIG. NO.: 3-6
REVISION NO. 1 7 JULY 1993		

4

Table 4-2 : Well Development Data

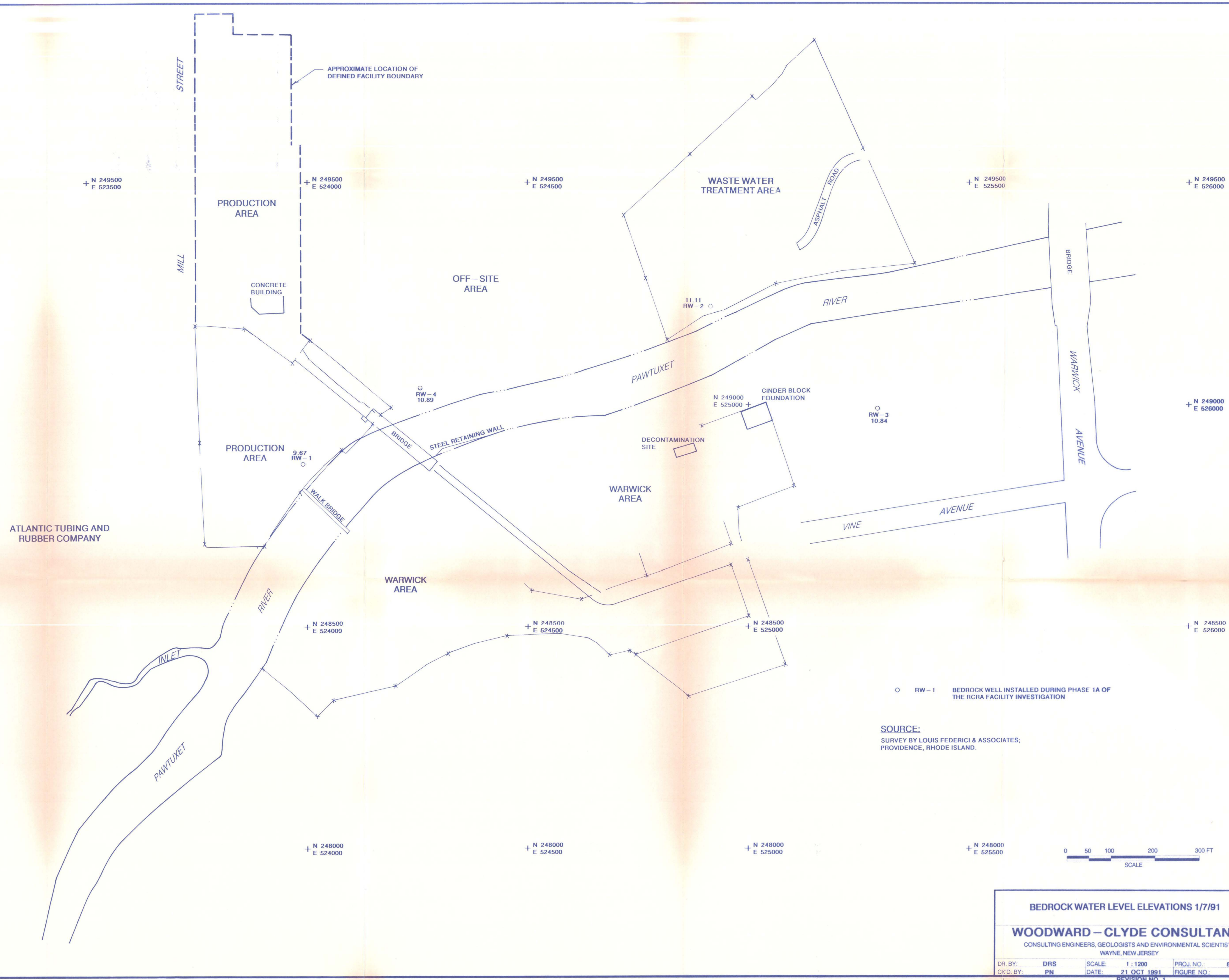
Well/ Piezometer Number	Date Of Development	Screened Interval		Depth of Well		Depth To Water (feet)	Volume Of Water Removed (gallons)	Field Parameters						Method Of Development*
		From (feet)	To (feet)	Start (feet)	End (feet)			Temp (C)	Initial Turbidity (NTU)	Conductance (uS/cm)	Temp (C)	Final Turbidity (NTU)	Conductance (uS/cm)	
P-1S	12/18/90	9.84	12.84	10.47	NA	6.56	2	NA	NA	NA	NA	NA	NA	P
P-1D	12/20/90	42.74	45.74	48.09	NA	7.24	6	NA	NA	NA	NA	NA	NA	P
P-2S	12/18/90	9.15	12.15	12.13	NA	4.48	0.75	NA	NA	NA	NA	NA	NA	P
P-3S	12/18/90	9.65	12.65	11.14	NA	7.18	4	NA	NA	NA	NA	NA	NA	P
P-4S	12/18/90	15.95	18.95	17.28	NA	7.76	6	18	>200	260	18.5	133	170	P
P-5S	12/18/90	15.75	18.75	17.35	NA	9.68	5	NA	NA	NA	NA	NA	NA	P
P-6S	12/18/90	17.09	20.09	17.85	NA	11.97	4	NA	NA	NA	NA	NA	NA	P
P-6M	12/20/90	37.52	40.52	39.51	NA	9.98	7	NA	NA	NA	NA	NA	NA	P
P-7S-A	12/14/90	7.53	10.53	9.38	NA	5.37	4.5	NA	NA	NA	NA	NA	NA	P
P-7S-B	12/14/90	12.05	15.05	14.88	NA	4.82	12.5	NA	NA	NA	NA	NA	NA	P
P-8S	12/14/90	9.67	12.67	12.43	NA	9.20	5	NA	NA	NA	NA	NA	NA	P
P-9S	12/14/90	10.22	13.22	12.98	NA	7.54	7	NA	NA	NA	NA	NA	NA	P
P-10S	12/12/90	10.63	13.63	12.00	NA	6.90	5	NA	NA	NA	NA	NA	NA	P
P-11S	12/17/90	10.45	13.45	10.52	NA	5.73	5.5	NA	NA	NA	NA	NA	NA	P
P-12S-A	12/17/90	10.08	13.08	12.00	NA	6.56	0.75	NA	NA	NA	NA	NA	NA	P
P-12S-B	12/17/90	13.11	16.11	15.00	NA	5.82	1	NA	NA	NA	NA	NA	NA	P
P-13S	12/19/90	14.17	17.17	17.13	NA	13.09	1.3	NA	NA	NA	NA	NA	NA	P
P-14S	12/19/90	10.44	13.44	12.75	NA	9.16	3	NA	NA	NA	NA	NA	NA	P
P-14D	12/19/90	47.27	50.27	50.34	NA	8.65	22	NA	NA	NA	NA	NA	NA	P
P-15S	12/4/90	14.24	17.24	10.17	NA	6.56	2	14.4	>200	320	14.4	70	297	P
P-16S	12/4/90	14.53	17.53	NA	NA	8.94	17	13.4	95	129	13.6	47	131	P
P-17S	12/3/90	13.29	16.29	NA	NA	7.27	9	11.7	>200	81	15	>200	98	P
P-18D	12/13/90	64.86	67.86	NA	64.93	5.73	15.5	NA	NA	NA	NA	NA	NA	P
P-19D	12/17/90	28.61	31.61	30.41	NA	12.96	12	NA	NA	NA	NA	NA	NA	P
P-20S	12/19/90	18.42	21.42	20.64	NA	13.23	4	NA	NA	NA	NA	NA	NA	P
P-20D	12/19/90	22.69	25.69	22.49	NA	13.67	3	NA	NA	NA	NA	NA	NA	P
P-21S	12/3/90	15.77	18.77	NA	NA	9.68	1	12.5	137	170	9.6	>200	300	P
P-21D	12/3/90	35.71	38.71	NA	NA	5.64	14	12.9	122	103	12.5	78	210	P
P-22S	12/4/90	14.72	17.72	NA	NA	8.98	10	13.1	90	152	14	80	205	P
P-22D	12/4/90	55.97	58.97	NA	NA	6.43	5	12.5	24	NA	12.2	>200	NA	P
P-23D	12/13/90	84.00	87.00	87.60	NA	18.22	8	NA	NA	NA	NA	NA	NA	P
P-24D	12/13/90	28.00	38.00	39.16	39.21	17.64	12	NA	NA	NA	NA	NA	NA	P
P-25D	12/11/90	65.80	68.80	NA	NA	4.56	11	12.5	73	220	12.4	198	210	P
P-26S	12/4/90	13.75	16.75	NA	NA	7.24	8	14.1	>200	400	13.3	NA	650	P
P-26D	12/4/90	40.44	43.44	NA	NA	8.08	18	14.4	>200	223	12.5	38	259	P
P-27D	12/11/90	42.05	45.05	NA	NA	7.66	16	14.1	16	362	13	3	210	P

Table 4-2 : Well Development Data

Well/ Piezometer Number	Date Of Development	Screened Interval		Depth of Well		Depth To Water (feet)	Volume Of Water Removed (gallons)	Field Parameters						Method Of Development*
		From (feet)	To (feet)	Start (feet)	End (feet)			Temp (C)	Initial Turbidity (NTU)	Conductance (uS/cm)	Temp (C)	Final Turbidity (NTU)	Conductance (uS/cm)	
MW-1S	12/6/90	4.90	14.90	NA	NA	5.41	93	NA	NA	650			220	S
MW-1D	11/15/90	40.35	50.35	NA	NA	6.87	150	16	<200	170	15	11	350	S
MW-2S	11/15/90	9.90	19.90	NA	NA	4.51	47	15	13	370	15	43	525	C
MW-3S	11/15/90	10.04	20.04	NA	NA	7.79	80	18	>200	285	18	10	259	C
MW-4S	11/16/90	8.89	18.09	NA	NA	9.55	19	16	112	1600	16.5	60	500	C
MW-5S	12/10/90	8.35	18.35	NA	NA	11.35	150	14	>200	170	15	2	180	C
MW-6S	11/16/90	6.63	15.63	NA	NA	6.58	25	20.5	4	410	17	>200	280	C
MW-7S	12/10/90	10.25	20.25	NA	NA	7.65	82	12	>200	190	12	>200	180	C
MW-8S	12/10/90	17.94	17.94	19.15	NA	10.39	240	14	56	240	12.1	15	229	C
MW-9S	12/10/90	5.41	15.41	NA	NA	7.66	95	15	>200	170	14	>200	165	C
MW-10S	12/14/90	11.70	21.70	20.60	22.70	10.64	68	19.5	>200	780	14.8	>200	550	S
MW-10D	12/13/90	35.50	45.50	47.50	NA	9.47	260	12.1	>200	391	12.9	22	295	S
MW-11S	12/11/90	5.06	15.06	17.36	17.28	6.56	400	12	>200	222	12	>200	150	C
MW-12S	12/17/90	17.50	17.50	19.80	21.00	10.72	145	13.1	>200	540	14.7	110	445	C
MW-12D	12/18/90	35.60	45.60	44.00	NA	9.23	120	13.7	>200	310		114	323	S
MW-13S	12/14/90	17.19	17.19	19.20	19.60	7.76	154	10.5	>200	980	12.2	>200	960	C
MW-14S	12/13/90	8.67	18.67	21.30	NA	9.46	85	15.5	>200	410	15	>200	390	C
MW-15S	12/16/90	8.00	18.00	15.80	20.68	7.76	38.5	14	>200	312	13.2	184	375	S
MW-15D	12/10/90	35.00	45.00	46.50	NA	4.20	180	13	>200	1320	13	13	260	S
MW-16S	12/17/90	10.00	20.00	22.85	22.85	11.73	90	13	>200	335	13	>200	268	C
MW-16D	12/18/90	30.17	40.17	40.40	41.40	11.40	110	13.4	18	6900	13.1	96	4180	S
MW-17S	12/12/90	15.17	15.17	16.15	17.85	7.38	105	13	>200	215	13.9	>200	210	C
MW-17D	12/12/90	77.08	87.08	77.80	89.60	6.41	525	13.1	>200	1690	13	>200	250	S
MW-18S	12/13/90	14.67	24.67	26.00	28.10	19.20	63	14.2	>200	292	14	>200	272	C
MW-19S	12/13/90	9.67	19.67	23.30	23.30	17.90	13	15.2	>200	180	16	>200	190	C

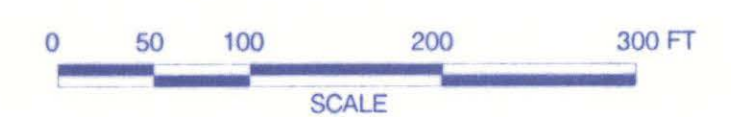
* C = CENTRIFUGAL, P = PERISTALTIC, S = SUBMERSIBLE

5/15/2013 10:10 AM C:\DATA\WELLS\WELL DEVELOPMENT DATA



○ RW-1 BEDROCK WELL INSTALLED DURING PHASE 1A OF THE RCRA FACILITY INVESTIGATION

SOURCE:
SURVEY BY LOUIS FEDERICI & ASSOCIATES;
PROVIDENCE, RHODE ISLAND.



BEDROCK WATER LEVEL ELEVATIONS 1/7/91

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WAYNE, NEW JERSEY

DR. BY:	DRS	SCALE:	1:1200	PROJ. NO.:	87X4660
CKD. BY:	PN	DATE:	21 OCT 1991	FIGURE NO.:	4-2
REVISION NO. 1 7 JULY 1993					



EP-8B
15.10

EP-8A
13.46

ATLANTIC TUBING AND
RUBBER COMPANY

PRODUCTION
AREA

CONCRETE
BUILDING

PRODUCTION
AREA

WARWICK
AREA

STEEL RETAINING WALL

WARWICK
AREA

WASTE WATER
TREATMENT AREA

CINDER BLOCK
FOUNDATION

VINE
AVENUE

BRIDGE

WARWICK
AVENUE

LEGEND:

- P-24D NEW DEEP PIEZOMETER (1990)
- P-24S NEW SHALLOW PIEZOMETER (1990)
- EP-1 EXISTING PIEZOMETER INSTALLED BY CIBA-GEIGY DURING THE COMMISSIONING OF THE FACILITY
- P-1S EXISTING PIEZOMETER INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- MW-11S NEW MONITORING WELL (1990)
- MW-6S EXISTING MONITORING WELL INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- RW-1 BEDROCK WELL INSTALLED DURING PHASE 1A OF THE RCRA FACILITY INVESTIGATION
- SG-1 STREAM GAUGE
- EQUIPOTENTIALS
- FLOW LINES
- B-B' CROSS-SECTION LINE

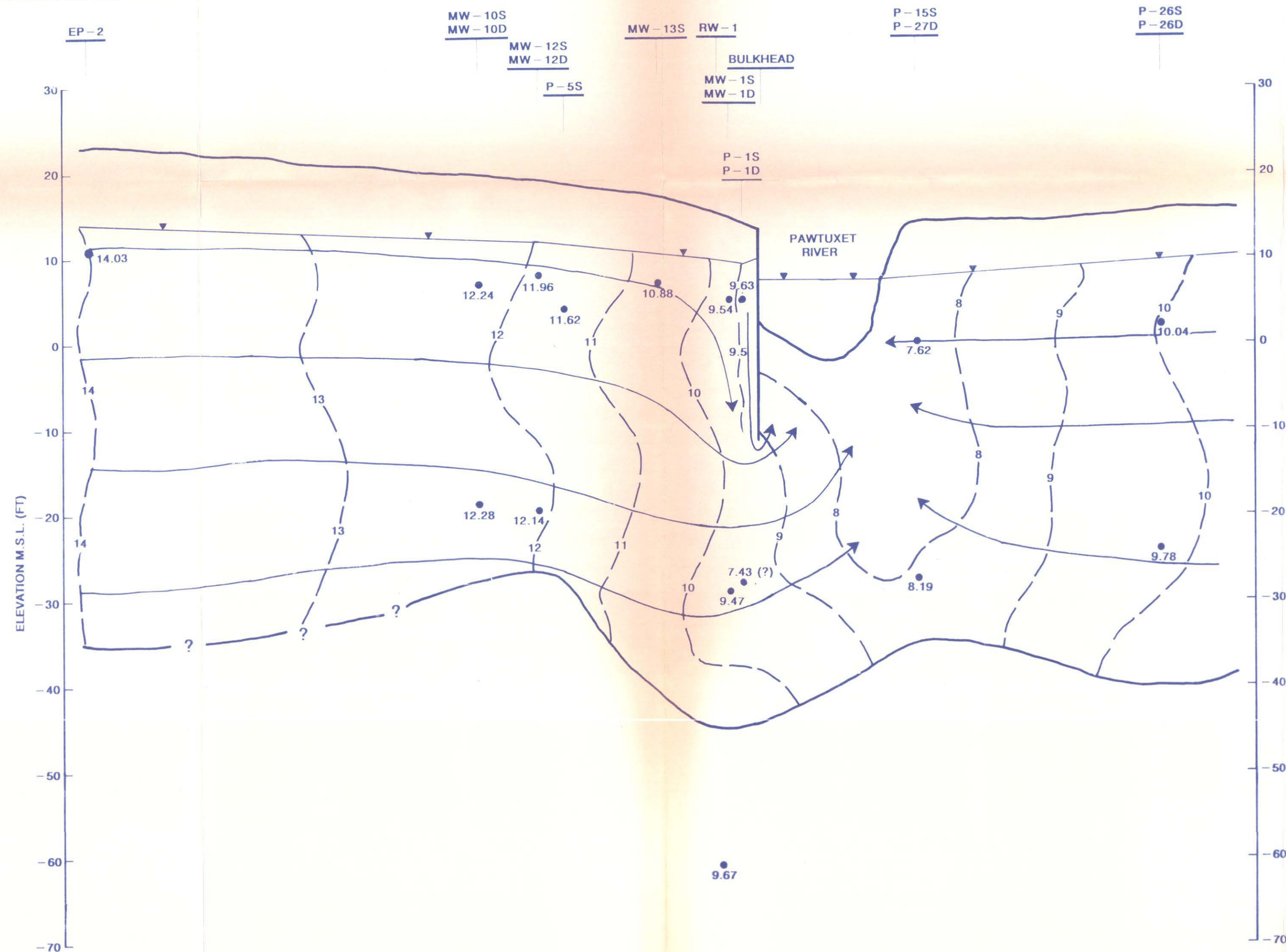
SOURCE:

SURVEY BY LOUIS FEDERICI & ASSOCIATES;
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WATER TABLE CONTOURS - SHALLOW OVERBURDEN
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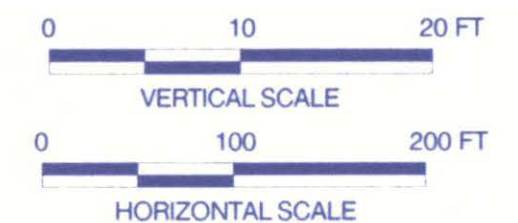
DR. BY: KF	SCALE: 1" = 1200'	PROJ. NO.: 87X4660
CHKD. BY: JD	DATE: 21 OCT 1991	FIGURE NO.: 4-3
REVISION NO. 1 7 JULY 1993		



LEGEND

- WELL SCREEN MID-POINT AND HYDRAULIC HEAD
- - - EQUIPOTENTIALS
- GROUNDWATER FLOW DIRECTION

LOCATION OF CROSS-SECTION SHOWN ON FIGURE 4-3.



CROSS-SECTIONAL FLOW DIAGRAM A-A'

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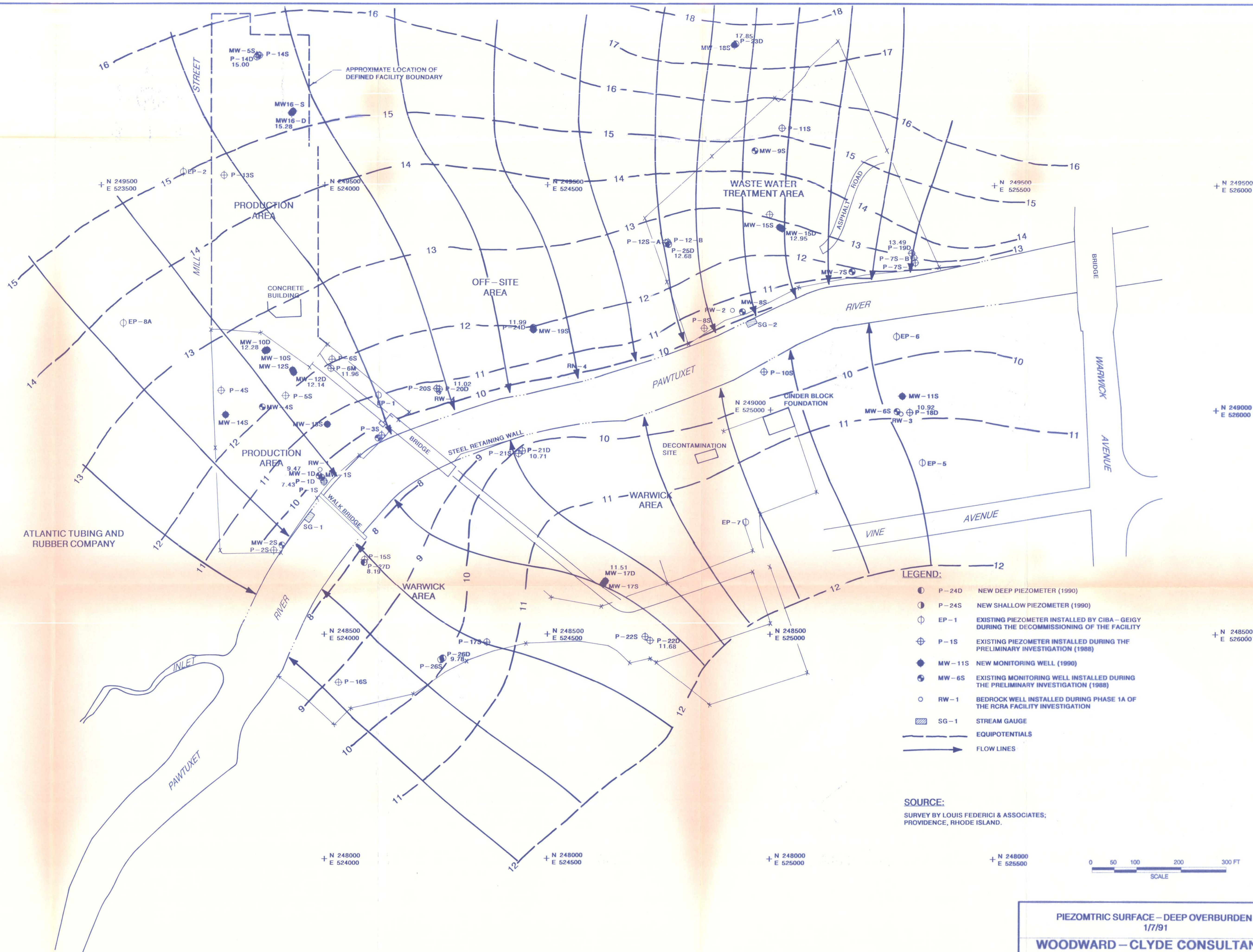
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DR. BY: MG	SCALE: AS SHOWN	PROJ. NO: 87X4660
CK'D BY: MH	DATE: 21 OCT 1991	FIG. NO: 4-4

REVISION NO. 1
12 JULY 1993



EP-8B



LEGEND:

- P-24D NEW DEEP PIEZOMETER (1990)
- P-24S NEW SHALLOW PIEZOMETER (1990)
- EP-1 EXISTING PIEZOMETER INSTALLED BY CIBA-GEIGY DURING THE DECOMMISSIONING OF THE FACILITY
- P-1S EXISTING PIEZOMETER INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- MW-11S NEW MONITORING WELL (1990)
- MW-6S EXISTING MONITORING WELL INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- RW-1 BEDROCK WELL INSTALLED DURING PHASE 1A OF THE RCRA FACILITY INVESTIGATION
- SG-1 STREAM GAUGE
- EQUIPOTENTIALS
- FLOW LINES

SOURCE:

SURVEY BY LOUIS FEDERICI & ASSOCIATES, PROVIDENCE, RHODE ISLAND.



PIEZOMETRIC SURFACE - DEEP OVERBURDEN
1/7/91
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WAYNE, NEW JERSEY

DR. BY: KF	SCALE: 1:1200	PROJ. NO.: 87X4660
CKD. BY: JD	DATE: 21 OCT 1991	FIGURE NO.: 4-5
REVISION NO. 1 7 JULY 1993		

P-14S
P-14D

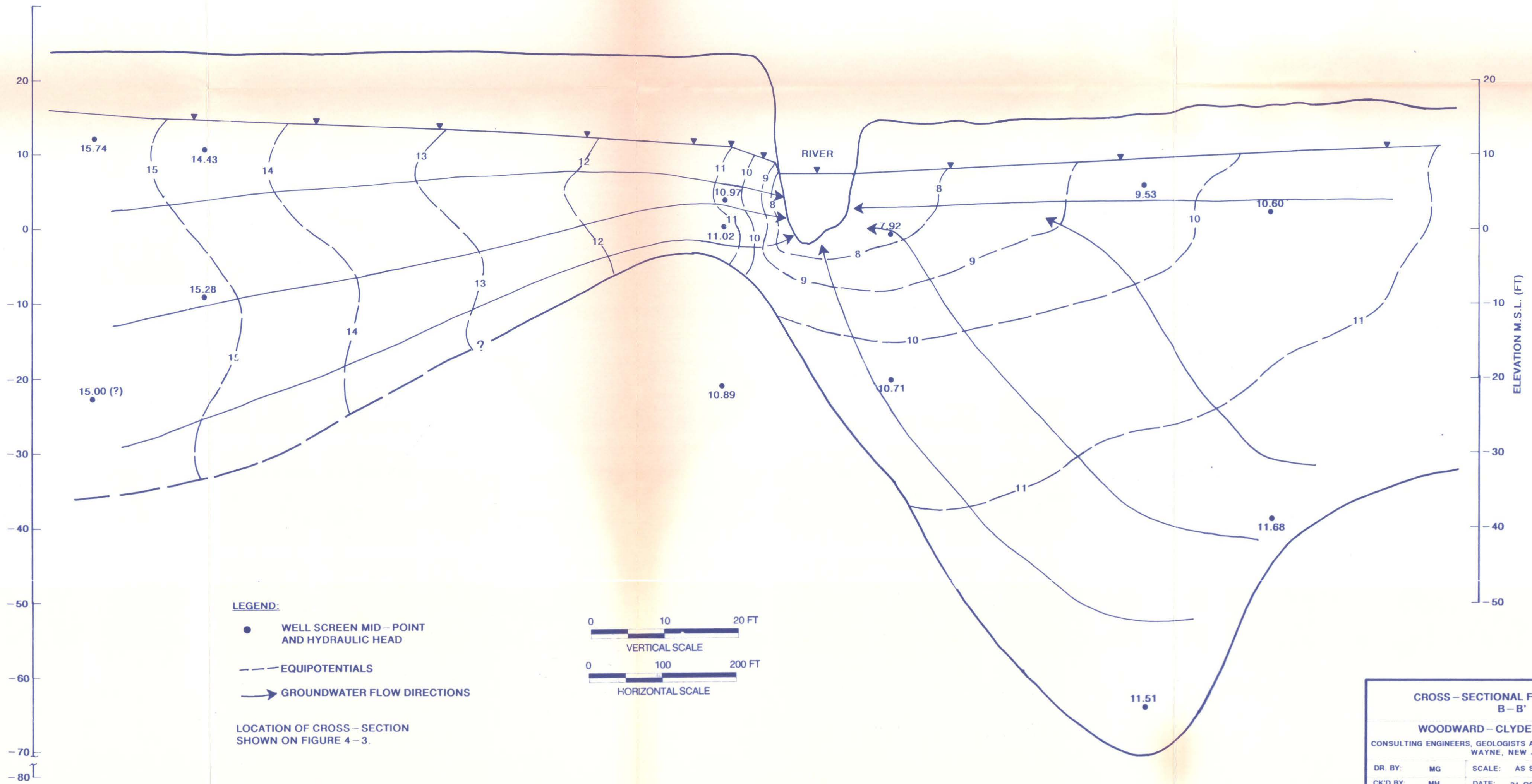
MW-16S
MW-16D

P-20S
P-20D
RW-4

P-21S
P-21D

MW-17S
MW-17D

P-22S
P-22D



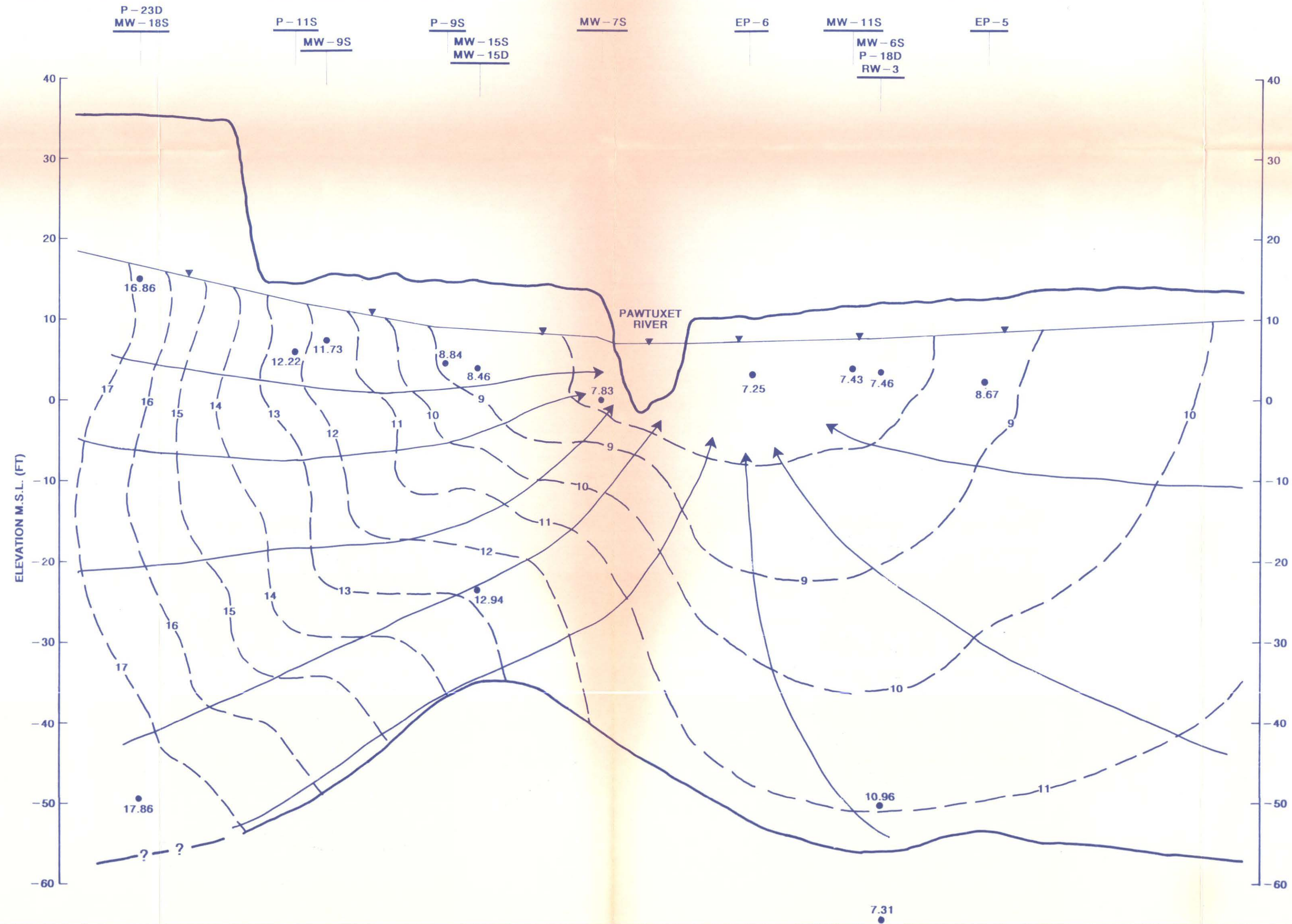
CROSS-SECTIONAL FLOW DIAGRAM
B-B'

WOODWARD-CLYDE CONSULTANTS

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WAYNE, NEW JERSEY

DR. BY:	MG	SCALE:	AS SHOWN	PROJ. NO:	87X4660
CK'D BY:	MH	DATE:	21 OCT 1991	FIG. NO:	4-6

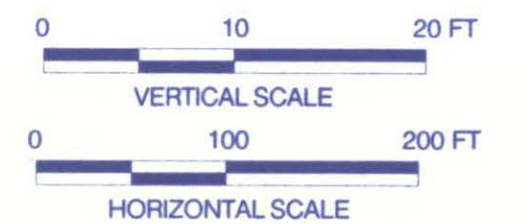
REVISION NO. 1
7 JULY 1993



LEGEND:

- WELL SCREEN MID-POINT AND HYDRAULIC HEAD
- - - EQUIPOTENTIALS
- GROUNDWATER FLOW DIRECTIONS

LOCATION OF CROSS-SECTION SHOWN ON FIGURE 4-3.



CROSS-SECTIONAL FLOW DIAGRAM C-C'

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY: MG	SCALE: AS SHOWN	PROJ. NO: 87X46C0
CK'D BY: MH	DATE: 21 OCT 1991	FIG. NO: 4-7

REVISION NO. 1
12 JULY 1993

6

6.3.3 Summary of the Release Characterization at SWMU-3

The Phase I release characterization investigated both soil and groundwater at SWMU-3; the results are summarized here for both Media of Concern.

Soil. The following results were obtained for the five soil samples from SWMU-3.

Fraction	Number of Analytes Detected	Minimum and Maximum Detected Concentrations (ppm)	Range of Total Concentr'n's (ppm)	Mean Total Concentr'n (ppm)	Med'n Total Concentr'n (ppm)
VOCs	1 - 5	0.014 - 33	0.041 - 48	20	145
Semi-Volatiles	0 - 7	0.081 - 1.2	ND - 4.3	1.6	1.3
PCBs	1 - 1	1.4 - 4.3	1.4 - 4.3	3.24	3.4
Dioxins/Furans	0 - 1	0.00055 - 0.0011	ND - 0.0011	0.0005	0.0005
Pesticides/Herbicides	1 - 2	0.0037 - 0.18	0.0037 - 0.19	0.05	0.02
Metals/Cyanide	The following exceeded baselines: calcium (1), magnesium (1), potassium (2), zinc (1), cyanide (1)				

Groundwater. The following results were obtained for the four groundwater samples from SWMU-3.

Fraction	Number of Analytes Detected	Minimum and Maximum Detected Concentrations (ppb)	Range of Total Concentr'n's (ppb)	Mean Total Concentr'n (ppb)	Med'n Total Concentr'n (ppb)
VOCs	4 - 5	1.1 - 2400	55 - 5020	2052	1566
Semi-Volatiles	2 - 7	1 - 1100	17 - 1158	321	55
PCBs	0 - 1	30 - 30	ND - 30	7.5	ND
Dioxins/Furans	0 - 0	—	—	—	—
Pesticides/Herbicides	0 - 2	0.01 - 0.047	ND - 0.047	0.028	0.032
Metals/Cyanide	Total metals exceeding baselines: iron (4), manganese (4) Dissolved metals exceeding baselines: iron (4), manganese (4)				

6.4 SWMU-4: TRASH COMPACTOR STATION

SWMU-4 was a trash compactor station located on a concrete pad (21 feet by 36 feet) north of Building 27 in the Production Area. There were two compactors, of 30- and 55-cubic yard capacity, respectively. The compactors handled packaging material, waste paper, and washed fiber drums. All potentially contaminated surface water from the Production Area, including water that collected in the pad area, was sent to the Waste Water Treatment Plant.

No releases from this area are known or suspected. Any releases from the compactor would have collected at the drainage sump and then flowed to the Waste Water Treatment Plant. The trash compactor station was decommissioned prior to conducting the on-site sampling investigations. Media of Concern were not sampled during the Facility Assessment or the Preliminary Investigation. Investigation of this unit is not required by the Order; SWMU-4 will not be investigated as part of the Facility Investigation.

Table 6-3. Production Area Soil Borings: Inorganic Data Summary

	SWMU-2					SWMU-3					SWMU-7				SWMU-8					SWMU-11					AAOI-15			Background Soil Range	
	B-2A	B-2B	B-2B	B-2C	B-2D	B-3A	B-3A	B-3B	B-3C	B-3D	B-7A	B-7B	B-7B	B-7C	B-8A	B-8B	B-8B	B-8C	B-8C-DUP	B-11A	B-11B	B-11B-DUP	B-11B	B-11C	SS-MW-16S	SS-MW-16S	B-15A		
date:	11/19/90	11/19/90	3/14/91	3/14/91	3/15/91	11/20/90	3/18/91	11/19/90	3/18/91	3/18/91	11/20/90	11/20/90	3/18/91	3/18/91	11/20/90	11/20/90	3/14/91	3/14/91	3/14/91	12/6/90	11/20/90	11/20/90	3/15/91	3/15/91	12/5/90	3/14/91	3/14/91		
depth:	8' - 10'	6' - 8'	6' - 8'	6' - 8'	6' - 8'	6' - 8'	6' - 8'	6' - 8'	2' - 4'	6' - 8'	2' - 4'	0 - 2'	0 - 2'	4' - 6'	0 - 2'	0 - 2'	0 - 2'	4' - 6'	4' - 6'	3' - 5'	3' - 7'	3' - 7'	3' - 7'	5' - 7'	8' - 10'	8' - 10'	2' - 4'		
INORGANICS																													
arsenic	8.2 J	11.3 J	1.5	4.8	15	5.6 J	6.4 J	8.6 J	10.4 J	8.5 J	2.5 J	4.2 J	5.3 J	9.5 J	8.1 J	2.5 J	9.2	7	8.8	5.9 J	6.9 J	6.3 J	3.3	4.5	5.8 J	4.3	11.2	5.2-36.9	
barium	11.6	24.1	20.1	32.4	35	14.5	7.8 J	12.2	25.8 J	41 J	15	21	29.4 J	14.4 J	27.8	37.1	49.6	26.6	39.4	16.2	25.2	32.4	25.5	21.4	13.9	10.7	23.4	12.1-275	
beryllium	0.34	0.56		0.2	0.38	0.31		0.4	0.33 J	0.4 J	0.25	0.38	0.3 J	0.23 J	0.64	0.69	0.53	0.33	0.53	0.47	0.49	0.61	0.39	0.27		0.22	3.8	0.25-0.77	
cadmium		0.56								0.52		0.60	0.59					0.57										0.52-0.78	
calcium	584 J	2120 J	608	4450	762	1180 J	829 J	682 J	987 J	24600 J	6070 J	6590 J	10700 J	747 J	6170 J	8440 J	46600	173	3550	104 J	4910 J	5840 J	7770	1040	929 J	673	1180	560-1,440	
chromium	12.6	16.6	1.6 J	7 J	15.3 J	9.9	7.8 J	11	7.4 J	9.4 J	4.9	6	8.5 J	6.6 J	6.3	8.3	12.9 J	0.6 J	12.7 J	4.3	8.2	7.6	6.8 J	19 J	4.5	4.5 J	9.2 J	6.2-20	
cobalt	8.6	7.7		3.2	7.8	4.3	3.6	5.0	3.8	3.2	1.4	2.6	2.3	3.1	2.6	2.4	4.3		6	2.5	4.5	3.9	2.9	3	2.9	2.8	4	1.8-7	
copper	13.2	25.6	1.5 J	7.2 J	19.4 J	18.2	9.3	9.5	9.4	8.4	11.8	6.7	11.1	8.7	6.5	11.2	19.7 J	0.81 J	13 J	1.8	8.0	6.6	8.4 J	5.8 J	2.6	5.6 J	9.8 J	3.8-22.9	
iron	17800	23900	1900	9830	29900	10400	11000 J	13600	9940 J	10600	4350	7170	8490 J	9920	7240	8030	11600	925	17200	9500	10300	11100	8840	15000	10600	9440	10600	7,240-28,300	
lead	11	13.6 J	8.1 J	15 J	15.5 J	11	5.3	11	19.6	13.7	17	15	23.6	16.9	19	23	16 J	7.1 J	9.6 J	6.1 J	11	12	6.8 J	4.3 J	3.3 J	3 J	20.5 J	11.8-471	
magnesium	3590 J	4210 J	201 J	1660 J	4640	1730 J	1710	2490 J	1290	1760	706 J	1230 J	2600	1310	1120 J	1170 J	2680 J	108 J	2240 J	900 J	1340 J	1530 J	1220	1100	1190 J	930 J	1340 J	683-2,450	
manganese	243 J	330 J	17 J	121 J	240 J	128 J	107 J	211 J	190 J	178 J	63.4 J	122 J	145 J	91.1 J	110 J	133 J	179 J	15.2 J	254 J	141 J	200 J	284 J	159 J	120 J	106 J	151 J	211 J	53.2-476	
mercury									0.06	0.24	0.11	0.15	0.26	0.16	0.11	0.25	0.62	0.33			0.34	0.33	0.18	1.6			0.11	0.047-0.81	
nickel	17.6	19.4		6	21	9.1	7.6	11.2	7.2	7.4	6.8	5.9	8.4	7.3	3.7	5.1	7.2		11.4		5.2	5.2	4	4.8		3.8	6.3	1.5-13.3	
potassium	307 J	528 J	386 J	433 J	711 J	417 J	328	448 J	417	1210	551 J	739 J	645	445	696 J	685 J	1000 J	73 J	1100 J	536 J	658 J	971 J	637 J	1040 J	826 J	603 J	648 J	349-786	
sodium			180	187	268		141		149	219			150	156			234		316				331	350		181	184	77-230	
vanadium	10.6	15.6	3.8	10.4	17.9	12.4		9.1			4.9	9.7			7.5	8.4	16.5		14.5	6.9	8.5	7.7	8.8	7.2	6.4	6.4	14.7	11.3-27.3	
zinc	70.8 J	58.6	2.2 J	26.1 J	49.1 J	144 J		38.8 J		318	49.5 J	87.2 J	178		136 J	319 J	321 J	3.2 J	68	30.1	39.9 J	51.8 J	38.2 J	28.2 J	20.6	21 J	41.2 J	17.4-219	
cyanide									13.6 J	1 J			0.82 J	11.1 J	1.7	1.2	1												0.45-3

all concentrations in mg/kg (ppm).
all shaded values exceed the Background Soil Range.
* these lower values are detection limits, not concentrations detected.
J - estimated concentration.

11



SELECTION OF INDICATOR COMPOUNDS

11.1 OVERVIEW

The contents of this section relate to the fifteen health and environmental risk assessments required for the CIBA-GEIGY facility. Under the Order entered into by CIBA-GEIGY and USEPA (hereafter, simply "EPA") Region I in 1990, these risk assessments constitute the Public Health and Environmental Risk Evaluation (PHERE), which is a portion of the RCRA Facility Investigation of the Cranston site. These risk assessments are being carried out according to a Work Plan submitted to EPA Region I in March 1991 and subsequently approved. In this chapter, mention of the approved Work Plan refers specifically to Volume 1, Chapter 2, Section 1 of the RCRA Facility Investigation Proposal, which is the section describing the PHERE.

Fourteen of the risk assessments apply to the areas of study at the Cranston site, as defined in the approved Work Plan: ten SWMUs, one AOC, and two AAOIs. The fifteenth risk assessment applies to the Pawtuxet River, which is a separate investigation from the Cranston site. This report contains information on the first step of these risk assessments, the selection of indicator chemicals (sometimes called "indicator compounds").

Indicator chemicals are defined as all those chemicals detected at least once in each medium of each area of study. This definition of indicator chemicals is only for purposes related to the Facility Investigation of the Cranston site. The term as defined here is not to be confused with "indicator chemical" as defined in the Superfund Public Health Evaluation Manual (EPA, 1986).

Selection of indicator chemicals is based on results of analyses of samples gathered during Rounds 1 and 2 of Phase I studies. Phase II sampling in each medium of each area of study will be limited to those chemicals identified in this section. The completed PHERE will be included in the RCRA Facility Investigation Report to EPA Region I.

Environmental samples were analyzed for those chemicals appearing on Appendix IX to 40 CFR, Part 264 (EPA, 1991d), for chlorinated dioxin and furan compounds, and for certain CIBA-GEIGY products ("fingerprint compounds"), as defined in the approved Work Plan. The objective of this portion of the PHERE is to identify from validated data all chemicals present in environmental media based on Phase I studies. Detected chemicals in each medium of each area of study will then be analyzed for during Phase II studies.

11.1.1 Preview of Chapter Sections

Data are presented and discussed in Section 11.2 on those chemicals identified in each medium of each of the fourteen areas of study and in the Pawtuxet River. Detected chemicals are identified for soil only, soil and groundwater, or sediment and surface water, depending on the nature of the study area. Information on tentatively identified compounds (TICs) is presented in Section 11.3. Certain TICs were selected as indicator chemicals for individual media in areas of

study; these were then added to the list of indicator chemicals to be analyzed for in that medium during Phase II studies. Limits of detection were high for some analytes in some samples. Data on detection limits are presented in Section 11.4, together with a discussion of the impact of high detection limits on the risk assessments. Some chemicals with high detection limits are included as indicator chemicals. In addition to collecting and analyzing environmental samples for all indicator chemicals, Phase II studies will include analysis of additional samples of soil or sediment for a shorter list of "target chemicals" (sometimes called "target compounds"). The analytes detected in soil or sediment in each area of study are ranked in Section 11.5 according to both concentration and toxicity. The method of ranking employed was derived from the approved Work Plan. Section 11.6 gives a summary of these presentations of data on analytes detected at the Cranston site.

11.1.2 Data Presentation

The data described and referred to in this section are presented in tables in Appendix X and Appendix AA. The tables are arranged to correspond to the four clusters of study areas. The Production Area includes SWMU-2, SWMU-3, SWMU-7, SWMU-8, SWMU-11, AOC-13, and AAOI-15. The Warwick Area includes SWMU-5, SWMU-6, SWMU-9, and AAOI-16 (also known as "SWMU-16"). The Waste Water Treatment Area includes SWMU-10, SWMU-12, and a pond. The off-site area includes the Pawtuxet River near the Cranston site and designated sites where background samples were collected. Figure 1-2 shows the spatial relationships of the areas of study.

Tables X-1 through X-15. These summaries present data on those chemicals which were both identified and detected, one table for each of the fifteen areas of study. Media are separated; organic and inorganic chemicals are also separated. The data presented include frequencies of detection, ranges of detected concentrations, and ranges of detected concentrations in off-site samples defined as background. These tables do not present data on compounds which were not detected.

Tables X-16 through X-30. These summaries present numbers of detections and ranges of detected concentrations for TICs by area of study and medium.

Tables X-31 through X-43. These summaries are a reformatting of data from Tables X-1 through X-29; no such summary is presented for background data in Table X-30. For the twelve areas of study which contained two environmental media, either soil and groundwater or surface water and sediment, ranges of concentrations of indicator chemicals are juxtaposed to discern possible trends in transport between media. No groundwater data were collected in SWMU-3, but SWMU-7 is immediately downgradient. Therefore, an additional table (X-32) was prepared showing data from SWMU-3 soils and SWMU-7 groundwater. Data on the TICs retained as indicator chemicals are also shown on these tables.

Tables X-44 through X-46. These three tables present for all analytes, detected or not, information on carcinogen classifications and cancer potency factors, chronic oral reference doses, numbers of samples analyzed, and minimum and maximum detection limits. These data are used to compare observed detection limits in Phase I studies to concentrations associated with minimal risk.

Tables X-47 through X-61. Tables X-47 through X-61 present the results of ranking the chemicals in soils by their toxicity and concentrations. This ranking was used to select for each area of study target chemicals as analytes for certain additional sampling planned for Phase II studies.

Tables X-62 through X-77. These tables present a complete list of the chemicals to be analyzed for in Phase II studies. For each area and medium, the complete list consists of: all chemicals identified and detected; TICs considered to be of importance; and substances whose minimum detection limits in Phase I studies were higher than calculated risk-based levels. Also, tetra-, penta-, and hexachlorinated dibenzo-*p*-dioxins and dibenzofurans (listed as PCDDs and PCDFs) are included as indicator chemicals in all media and areas of study.

Tables AA-1 through AA-13. These tables present number of samples analyzed, number of non-detects, the range of detection limits for non-detected data, and a comparison of detection limits to risk-based screening levels for soil samples analyzed in Phase I. These tables are essentially the same as Table X-46, broken down on a SWMU-by-SWMU basis.

Tables AA-14 through AA-23. These tables present number of samples analyzed, number of non-detects, the range of detection limits for non-detected data, risk-based screening levels or MCLs, and RCRA-recommended sample quantitation limits for groundwater samples analyzed in Phase I. These tables are essentially Table X-45 broken down on a SWMU-by-SWMU basis.

Table AA-24. This table summarizes the detection limit analysis presented in Tables AA-1 through AA-13.

11.13 Data Reliability

Difficulties were experienced in entering and retrieving combined analytical data from Round 1 and Round 2 of Phase I studies. These difficulties stem from the fact that the data from the two rounds are maintained in separate data bases (as discussed in Appendix B). For the assembly of this report it was not possible to query both data bases simultaneously. Therefore, the tables in Appendix X were assembled from separate queries to the two data bases. Verifying combined data on a parameter from both rounds of results was problematic. This difficulty is being corrected by transferring all data bases to a larger hardware system, one capable of handling analytical data from the several rounds of sampling which will eventually be available from studies in both Phase I and Phase II.

We consider that the *qualitative* aspects of the data reported here are reliable, with the exception of chlorinated dioxins and furans, which are discussed in Section 11.2.1. For instance, we feel that we have reliably reported each detection of a chemical in the areas of study. However, because Rounds 1 and 2 might not be combined properly in all cases, the *quantitative* aspects reported here, such as ranges of values, must be considered preliminary at this time. Some quantitative aspects of the analytical data are examined in the discussion on detection limits in Section 11.4. These discussions must also be considered preliminary. The concentration/toxicity rankings described in Section 11.5 use quantitative information also, but we consider that the data presented in this report are adequate for the purposes of this gross ranking of these chemicals.

11.2 CHEMICALS IDENTIFIED AT THE CRANSTON SITE

According to EPA guidance (EPA, 1989b; EPA Region I, 1989), health and environmental risk assessments are performed with consideration for a set of chemicals defined as Constituents of Potential Concern. These constituents are selected from all the chemicals detected in the various environmental media according to methods described in Section 1.5.5 of the approved Work Plan. Analytical data from Phase I studies provide enough information to identify the chemicals present in each medium of each of the fifteen areas of study. These detected chemicals in each medium of each area of study are defined as indicator chemicals. This definition of indicator chemicals is only for purposes related to the RCRA Facility Investigation of the Cranston site. Indicator chemicals as defined here are not to be confused with the term "indicator chemical" as it is employed in the Superfund Public Health Evaluation Manual (EPA, 1986).

Candidates for the lists of indicator chemicals come from three categories described in this section: chlorinated dibenzofurans and dibenzo-*p*-dioxins, fingerprint compounds, and those chemicals listed in Appendix IX to 40 CFR, Part 264, (EPA, 1991d). A fourth category, tentatively identified compounds (TICs), is described in Section 11.3.

11.2.1 Chlorinated Dioxins and Furans

Among the chlorinated dioxins and furans, Appendix IX includes total tetra-, penta-, and hexachlorodibenzo-*p*-dioxins; total tetra-, penta-, and hexachlorodibenzofurans; and the specific isomer, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. Results of assays for these substances are reported in the Tables X-1 through X-15.

Tetrachlorodibenzofurans were detected in soils at least once in eleven of the fourteen areas of study on-site and in sediment in the Pawtuxet River. The other tetra-, penta-, and hexachlorinated dibenzo-*p*-dioxins and -dibenzofurans were detected much less often. CIBA-GEIGY sought to confirm these results by engaging a referee laboratory to perform duplicate analyses. Results from the two laboratories differed, and these differences could not be resolved. It was therefore decided that the analyses of chlorinated dioxins and furans from Phase I studies were not useable. The EPA Regional Project Manager was kept informed of these events as they unfolded.

The Phase II Proposal (Volume 2 of this report) contains a sampling plan for chlorinated dioxins and furans which will meet the needs of the PHERE. Adequate qualitative and quantitative information will be generated for assessing possible risks due to the presence of these substances. In addition to the requisite analyses for total tetra-, penta-, and hexachlorinated forms, assays for specific isomers with chlorine atoms in the 2, 3, 7, and 8 positions will also be reported. This will permit results of Phase II studies to be reported as 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalents (TEQs), according to the most recent EPA guidelines (EPA, 1989a). TEQs will also be reported for any 2,3,7,8-hepta- and -octachlorinated forms detected, thus permitting a complete assessment for this class of chemicals.

11.2.2 CIBA-GEIGY Fingerprint Compounds

Fingerprint compounds are specific chemicals unique to the activities at the CIBA-GEIGY facility at Cranston, Rhode Island. Selection of fingerprint compounds from all the products and

intermediates used at the Cranston facility is described in Section 1.5.5 of the approved Work Plan.

Selection of Fingerprint Compounds

Chemicals related to CIBA-GEIGY production activities at the Cranston facility were examined with respect to production volume, toxicity, and environmental persistence. Nine fingerprint compounds were selected: imipramine (Tofranil), phenylbutazone (Butazolidin), propazine, Tinuvin 327, Irgasan DP-300, and four by-products of Irgasan DP-300 (di- and trichlorinated dibenzo-*p*-dioxins and di- and trichlorinated dibenzofurans). Because Tinuvin 328 was produced in greater quantities than Tinuvin 327, Tinuvin 328 will be analyzed for in Phase II.

Results of Phase I Studies

Production Area. Irgasan DP-300 and its by-products, especially trichlorodibenzofuran, were a consistent finding in soil from SWMU-3 and in soil and groundwater from SWMU-7, SWMU-8, SWMU-11, and AOC-13. Dichlorinated by-products of Irgasan DP-300 were found in soils from SWMU-11. Tinuvin 327 was detected in soil in SWMU-3 and in both soil and groundwater in AOC-13. Butazolidin was detected in soil and groundwater from AOC-13, while Propazine was detected in AOC-13 only in groundwater. No fingerprint compounds were found in soils or groundwater of SWMU-2 or AAOI-15.

Warwick Area. Tinuvin 327 was detected in soils in SWMU-6 and SWMU-9 and in soil and groundwater in SWMU-5. Propazine was found in groundwater in SWMU-5. No fingerprint compounds were found in soils or groundwater of AAOI-16.

Waste Water Treatment Area. Irgasan DP-300 or its di- and trichlorodibenzofuran by-products were found in soils and groundwater in SWMU-12 and in sediment in the WWTA pond. Tinuvin 327 was found in soil in SWMU-12 and in sediment in the WWTA pond. Butazolidin and Tofranil were found in groundwater from SWMU-12. No fingerprint compounds were found in soils or groundwater of SWMU-10.

Off-Site Areas. Trichlorodibenzofuran was the only fingerprint compound detected in samples of sediment from the Pawtuxet River collected upstream of the facility reach. Tinuvin 327 and di- and trichlorodibenzofurans were found in sediments within or downstream from the facility reach. No fingerprint compounds were found in soils or groundwater off the Cranston site.

Recommendations for Phase II Studies

Fingerprint compounds were found in most media sampled in the Production Area. These chemicals were found much less often in the Warwick Area and the Waste Water Treatment Area. Fingerprint compounds should be sought in Phase II studies only in those media and areas of study where they were detected during Phase I. The affected study areas and environmental media are named above and are apparent from examination of Tables X-1 through X-15.

11.2.3 Appendix IX Compounds

All the Appendix IX chemicals detected are listed in Tables X-1 through X-15. The Production Area is described in Tables X-1 through X-7, the Warwick Area in Tables X-8 through X-11, the Waste Water Treatment Area in Tables X-12 through X-14, and the Pawtuxet River in Table X-15.

As discussed in Section 11.1.3, the qualitative aspects of these data are considered to be reliable. We consider it highly unlikely that a validated detection of a chemical in Phase I studies is not reported here. However, the quantitative information reported here, including exact frequencies of detection, ranges of detection limits, and ranges of detected concentrations, could change in future reports as our ability to query the analytical data base improves.

11.2.4 Transport of Indicator Chemicals Between Media

Two environmental media, either soil and groundwater or surface water and sediment, were sampled in twelve of the fifteen study areas. Tables X-31 through X-43 present the maximum concentration detected in each medium for all the indicator chemicals, including those TICs retained as indicators. The purpose of this presentation of data is to begin to examine the subject of transport between media. Phase II studies will address transport more directly. The data on organic indicator chemicals are discussed below for each study area. In most instances, chemicals are described by analytical fractions: fingerprint compounds, PCBs, organochlorine insecticides, organophosphorus insecticides, herbicides, semi-volatiles and volatiles. Because volatiles tend to be more mobile than most organics, these indicator chemicals are named individually. The three xylene isomers were reported either as m- and p-xylene (also denoted in other chapters as "m&p-xylene") or as o-xylene.

No meaningful discussion of the transport between media of inorganics or polychlorinated dioxins and furans can be presented at this time. Data on those TICs retained as indicator chemicals are presented in Tables X-31 through X-43, but no discussion is attempted because the identity of TICs is uncertain by definition.

It may not be possible to tie groundwater contaminants to a given SWMU as the source area, especially in the Production Area. Chemicals detected in the groundwater have multiple potential sources, including potential upgradient sources. For this reason, no attempt will be made to look in the soil for every analyte detected in the groundwater associated with a given SWMU.

Production Area

SWMU-2. Some 25 organic chemicals were detected in soil or groundwater in SWMU-2 (Table X-31). Just three of these were found in both media, two organochlorine insecticides and toluene. These data give little evidence for movement of chemicals between media in SWMU-2.

SWMU-3. Only soils were sampled in SWMU-3 during Phase I studies. However, if transport of chemicals has occurred, these chemicals could be observed in groundwater from SWMU-7, which is immediately downgradient from SWMU-3. Table X-32 presents data from soils in SWMU-3 and groundwater in SWMU-7. Of the 52 chemicals detected in either medium, nine were detected in both. These data suggest that some transport could be occurring between media. The nine chemicals were one fingerprint compound, PCB-1260 (also known as "Arochlor-

1260"), one organochlorine insecticide, two semi-volatiles, and four volatiles: ethylbenzene, toluene, m- and p-xylene(s), and o-xylene.

SWMU-7. Soils and groundwater in SWMU-7 were found to contain 49 chemicals (Table X-33). Ten of these were detected in both media, which suggests that some transport could be occurring. These were one fingerprint compound, PCB-1260, one organochlorine insecticide, four semi-volatiles, and three volatiles. The three volatiles were ethylbenzene, toluene, and m- and p-xylene(s).

SWMU-8. Sixteen of 53 chemicals were detected in both soil and groundwater in SWMU-8 (Table X-34). This suggests that some transport between media could have occurred. The sixteen chemicals consisted of one fingerprint compound, one organochlorine insecticide, nine semi-volatiles, and five volatiles. The five volatiles were chlorobenzene, ethylbenzene, toluene, m- and p-xylene(s), and o-xylene.

SWMU-11. Of the 63 organic chemicals in soils and groundwater in SWMU-11, 19 were found in both media, excluding tetrachlorodibenzofurans (Table X-35). This suggests that some transport of organics between media may have occurred in SWMU-11. Chemicals detected in both media included two fingerprint compounds, one organochlorine insecticide, one herbicide, ten semi-volatiles, and five volatiles. The five volatiles were ethylbenzene, toluene, 1,1,1-trichloroethane, m- and p-xylene(s), and o-xylene.

AOC-13. Organic chemicals in soils and groundwater in AOC-13 amounted to 97 substances, of which 41 were found in both media, once again excluding tetrachlorodibenzofuran (Table X-36). Thus, transport of organic chemicals between media in AOC-13 seems likely. The 41 chemicals detected in both media were three fingerprint compounds, seven organochlorine insecticides, three organophosphorus insecticides, two herbicides, 20 semi-volatiles, and six volatiles. The six volatile organic compounds were chlorobenzene, ethylbenzene, tetrachloroethane, toluene, m- and p-xylene(s), and o-xylene.

AAOI-15. Some 31 organic chemicals were detected in soils and groundwater of AAOI-15, but just three were found in both media (Table X-37). This suggests little transport of organic chemicals between media has occurred in this study area. The three organic chemicals detected in both media were two organochlorine insecticides and one volatile, toluene. This pattern is very similar to that found in SWMU-2 (Table X-31).

Warwick Area

SWMU-5. Seventy-four organic chemicals were identified for soils and groundwater in SWMU-5; seventeen of these were found in both media (Table X-38). These data suggest that some transport of organic chemicals between media has occurred in SWMU-5. The chemicals detected in both media included two fingerprint compounds, four organochlorine insecticides, one herbicide, five semi-volatiles, and five volatiles. The five volatiles were chlorobenzene, tetrachloroethane, toluene, m- and p-xylene(s), and o-xylene.

SWMU-6 and SWMU-9. Only soils were sampled in these study areas.

AAOI-16. Eleven organic chemicals were detected in soils and groundwater in AAOI-16 (Table X-39). Two of these were found in both media, an organochlorine insecticide and a volatile, toluene. The detected concentrations of both substances were near their respective detection limits in water (Table X-11). Taken together, these data suggest that little transport of organic chemicals has occurred between the media in AAOI-16 as sampled in Phase I studies.

Waste Water Treatment Area

SWMU-10. The chemicals detected in soils and groundwater in SWMU-10 included 39 organics, four of which were detected in both media (Table X-40). This suggests that little transport of organic chemicals between media has occurred in SWMU-10. The four organic indicator chemicals found in both media consisted of two organochlorine insecticides, one semi-volatile, and one volatile, toluene.

SWMU-12. Chemicals detected in soil and groundwater in SWMU-12 included 67 organics, of which 16 were detected in both media (Table X-41). These data suggest that some transport of organic chemicals between media has occurred in SWMU-12. The organics detected in both media included two fingerprint compounds, three organochlorine insecticides, six semi-volatiles, and five volatiles. The volatiles were chlorobenzene, ethylbenzene, toluene, m- and p-xylene(s), and o-xylene.

WWTA (SWMU-10) Pond. Some 23 organic chemicals were detected in surface water or sediment of the pond in the WWTA (Table X-42). Of these only two were found in both media, both organochlorine insecticides. These data present little evidence of transport of organic chemicals between media in this study area.

Off-Site Areas

Pawtuxet River. The occurrence of chemicals in surface water in the Pawtuxet River is potentially influenced by many factors in addition to the CIBA-GEIGY facility at Cranston. Weather and upstream sources can change the composition of the surface water overnight. This is very much unlike the other, immobile areas of study on the Cranston site. Therefore, discussion of transport of organic chemicals between media at this point in the PHERE is more uncertain for the Pawtuxet River than is the case for on-site areas of study.

Chemicals detected in the Pawtuxet River included 80 organics, of which eleven were detected in both media (Table X-43). These data indicate that transport of organic chemicals might have occurred between media in the river. The organic chemicals detected in both surface water and sediment in the river were four organochlorine insecticides, two organophosphorus insecticides, one semi-volatile, and four volatiles. The volatiles were chlorobenzene, toluene, and the m- and p-xylene(s), and o-xylene.

11.3 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

11.3.1 Reporting and Use of TIC Data

The analytical methods employed in Phase I studies sought a specific suite of chemicals. Standard concentrations of each of the Appendix IX compounds and the fingerprint compounds were run along with each of the analyses reported here. Other "peaks" were often seen on

chromatograms and mass spectrograms, possibly indicating the presence of other chemicals in the sample under test. Sometimes these peaks could be tentatively identified as a particular chemical or as belonging to a defined class of chemicals. In most cases, however, the assigned identities of these tentatively identified chemicals or TICs are highly uncertain. Because no compound-specific standards were included in the analyses for TICs, the reported concentration of a TIC is also uncertain. Therefore, concentrations of TICs are assigned the data qualifier "J", according to established procedures for data validation (EPA, 1988).

Complete data summaries on TICs are not usually provided in a report of a site investigation (EPA, 1989b). Although the Order does not require the reporting of the concentrations of substances other than Appendix IX compounds, CIBA-GEIGY has examined the data on TICs and has decided to include certain TICs in the lists of indicator chemicals for individual media within the fifteen areas of investigation. These TICs will be sought in chemical analyses in Phase II studies. It must be noted, however, that only data on positively identified chemicals will ultimately be used in estimating risks.

11.3.2 Method of Examining TIC Data

All TICs encountered in Round 1 and Round 2 analyses of Phase I studies were printed out alphabetically without regard to location of the sample in which the TIC was reported. These lists of TICs were examined by qualified toxicologists for substances of interest, keeping in mind that the identity of the chemical names was questionable. The data bases were then queried for the TICs of interest in each area of study and environmental medium, including off-site soils and groundwater. TICs were then summarized by area of study and medium.

The TICs to be included as indicator chemicals were selected according to a few guidelines deemed appropriate in the judgement of qualified toxicologists. TICs were eliminated if they were detected only once in an area of study. Exceptions to this guideline were made if the name assigned to the TIC was that of a Class A, B, or C carcinogen (EPA, 1991a; 1991b), if the concentration of the particular TIC was relatively high (>1000 ppb), or if hits for the same TIC were observed in both media in the same area of study. A group of three related TICs were detected several times in both media but were eliminated nevertheless; these are described below. The decision on inclusion or exclusion of a particular TIC was then tempered by knowledge of which compounds had been identified in that area of study.

11.3.3 Results of Examination of TIC Data

The list of all TICs is presented in Appendix V, and the raw data on TICs have been supplied by CIBA-GEIGY to EPA Region I in project monthly reports. These data consisted of three types of entries:

- recognizable chemical names;
- unknown or unrecognizable chemical names (e.g., "UNKNOWN_3" or "C2-NAPHTHALENE"); or
- substances tentatively identified as various chlorinated biphenyls, with the number of chlorine atoms given but not their locations on the rings.

Reported concentrations of TICs were higher in soil and sediment than in surface water or groundwater. Low concentrations of ten or fewer TICs were reported for most samples collected. However, concentrations of individual TICs in some samples exceeded 100,000 parts per billion by weight ($\mu\text{g/kg}$ or $\mu\text{g/L}$). In one surficial soil sample taken from SWMU-5 (Round 1; grid location S12, A1), the summed concentration of all TICs was more than 1,300,000 $\mu\text{g/kg}$ or 0.13 percent by weight. Of this amount 1,092,000 $\mu\text{g/kg}$ or 84 percent of the total TICs in the sample were not assigned recognizable chemical names.

Toxicologists examining these data eliminated from consideration any TIC without a recognizable chemical name. Additional TICs were eliminated because the likelihood was considered to be very low that toxicological data could be located for the chemical name assigned to the TIC or that the TIC could even be classified with another group of compounds for which toxicological data are available. Some TICs were assigned the names of pharmaceuticals or their degradation products. It was decided that analyzing samples for the group of fingerprint compounds defined above was adequate to characterize any risks from this class.

All the TICs which remained after this winnowing process are summarized in Tables X-16 through X-30, one table for each area of study and one for off-site background. Numbers of detections, concentration ranges, and appearance in multiple media were now used as criteria for the final selection of TICs to be analyzed for in Phase II studies, which are marked with asterisks in these tables. The inclusion or exclusion of various TICs is discussed below.

1,1-Biphenyl. This chemical name, which does not appear on the Appendix IX list (EPA, 1991d), was identified in five study areas and in off-site background soil. It was decided to include 1,1-biphenyl in those media and areas of study where multiple hits were recorded. These were soil and groundwater in SWMU-11, groundwater in AOC-13, soil in SWMU-5, and in sediment of the Pawtuxet River.

2-Cyclohexene-1-ol, 2-Cyclohexene-1-one, and 2,5-Cyclohexadiene-1,4-dione. These three chemical names appeared in 8 areas of study and in off-site background samples, sometimes with multiple hits in a medium and sometimes in both media within an area of study. The highest concentration of any of the three TICs was found in sediment in the Pawtuxet River. These TICs could possibly be products either of microbial degradation or molecular fragmentation of polycyclic aromatic hydrocarbons (PAHs). The former cause would suggest that these TICs are actually present at the Cranston site, while the latter would suggest these are artifacts of mass spectrometric analysis. It was decided to seek all three compounds in sediment of the Pawtuxet River only, because this is the area with the highest concentrations of PAH among all the areas of study in or near the Cranston site.

cis-1,2-Dichloroethene in AOC-13 Groundwater. This TIC was detected three times at levels up to 24,000 $\mu\text{g/L}$ (Table X-21). The Order requires that groundwater be analyzed for the full Appendix IX list, including cis-1,2-dichloroethene, so this TIC need not be added to the list of indicator chemicals for AOC-13.

"Dichloroethylether" in SWMU-2 Soil. It was assumed that this assignation corresponds to bis(2-chloroethyl)ether, which is placed in carcinogen class B2, probable human carcinogen (EPA, 1991a). Therefore, bis(2-chloroethyl)ether was selected as an indicator chemical for soil in SWMU-2 (Table X-16).

Dimethoxyacetophenone in SWMU-12 Soil and Groundwater. This TIC was reported twice in both media in SWMU-12 (Table X-27). Dimethoxyacetophenone does not appear on the Appendix IX list, so this compound is selected as an indicator for both soils and groundwater in SWMU-12.

Methoxychlor in SWMU-5 Soil. This TIC was reported nine times at concentrations up to 740,000 µg/kg in soil (Table X-23) and toxicity data are readily available (EPA, 1991a). Therefore, methoxychlor was selected as an indicator chemical for soils in SWMU-5.

Methylbenzenesulfonamide in Pawtuxet River Surface Water. This TIC was reported four times in surface water in the Pawtuxet River (Table X-29) and toxicity data for this class of chemicals are readily available. Assuming an adequate analytical standard can be obtained, methylbenzenesulfonamide will be an indicator chemical for surface water in the Pawtuxet River.

Naphthalene in SWMU-11 Groundwater. This TIC was detected just once and at the relatively high concentration of 27,000 µg/kg (Table X-20). The Order requires that groundwater be analyzed for the full Appendix IX list, including naphthalene, so this TIC need not be added to the list of indicator chemicals for SWMU-11.

"Octane" in SWMU-3 Soil. It is assumed that this assignment refers to n-octane. This TIC was detected at an estimated concentration of 160,000 µg/kg in soil (Table X-17). Although just one detection is reported and n-octane is of a low order of toxicity, it was decided to include this TIC as an indicator chemical in SWMU-3 soils because of the relatively high reported concentration.

Oxy-bis(ethanol) in SWMU-10 Soil. This TIC was selected as an indicator chemical for soil in SWMU-10 because it was detected three times (Table X-26). Toxicity data are not readily available for oxy-bis(ethanol), but data are available for other short chain ethers and alcohols (EPA, 1991a; 1991b).

PCBs. Chlorobiphenyl or a PCB isomer was named as a TIC in 8 areas of study. It was decided to add PCBs as indicator chemicals wherever chlorobiphenyl or a PCB isomer was found as a TIC. PCBs had already been named as indicator chemicals in all these instances, except groundwater in SWMU-11. The Order requires that groundwater be analyzed for the full Appendix IX list, including PCBs. Therefore, these TICs are already indicator chemicals.

11.3.4 Summary

Following the methods outlined in this section, the TICs shown below have been designated as indicator compounds for Phase II studies at the Cranston site. These chemicals should be analyzed for in Phase II studies:

- 1,1-Biphenyl in soil in SWMU-5, in soil and groundwater in SWMU-11, in groundwater in AOC-13, and in sediment of the Pawtuxet River.
- bis(2-Chloroethyl)ether in soil in SWMU-2;
- n-Octane in soil in SWMU-3;

- Methoxychlor in soil in SWMU-5;
- Oxy-bis(ethanol) in soil in SWMU-10;
- Dimethoxyacetophenone in soil and groundwater in SWMU-12 ;
- Methylbenzenesulfonamide in surface water of the Pawtuxet River; and
- 2-cyclohexene-1-one, 2,5-cyclohexadiene-1,4-dione, and triphenylphosphate in sediment of the Pawtuxet River.

11.4 DETECTION LIMITS

11.4.1 Overview

High detection limits were encountered for some substances during analyses of environmental samples in Phase I studies. Such high limits could have obscured the detection of additional indicator chemicals for individual media and study areas (i.e., false negatives). In this section we compare risk-based concentrations of chemicals, calculated according to a proposed EPA method (EPA, 1990a), to the detection limits encountered in Phase I studies at the Cranston site. The purpose of this discussion is to evaluate the useability of those analytical data collected to date for the purposes of the PHERE. This analysis will be used in developing data quality objectives for analytical chemistry in Phase II studies.

11.4.2 Method of Analysis

Exposure Scenario

Risk assessment guidance from EPA (1989b; 1990b) suggests comparing observed detection limits with a level thought to be associated with a reasonable and acceptable level of risk. The purpose of such a comparison is to evaluate data for their adequacy in use for risk assessment. A method for calculating risk-based action levels in soil and water has been proposed by EPA (1990a). This method was used to estimate a risk-based level, using the scenarios and EPA-approved exposure factors, cancer potency factors and chronic oral reference doses (EPA, 1991a; 1991b, 1991c).

A highly conservative residential exposure scenario is used to calculate these levels. CIBA-GEIGY believes such a highly conservative tool can properly be used for the limited purpose of screening detection limits. However, CIBA-GEIGY does not regard the particular residential scenario employed here as necessarily appropriate for the ultimate assessment of health risk at the Cranston site. Appropriate exposure scenarios for purposes of risk assessment will be developed in the PHERE.

For Class A, B and C carcinogens, an intake is calculated which corresponds to an incremental lifetime cancer risk of 1×10^{-6} for an adult resident. Intake rates for an adult receptor are assumed to be of 100 mg soil or sediment per day and 2 liters of groundwater per day, 350 days per year, for a duration of 30 years, averaged over a lifetime of 70 years. It is further assumed that no correction is required for absorption (i.e. absorption factor = 1). For non-

carcinogens or substances of unknown carcinogenicity, the EPA-approved reference dose was used to calculate a level in soil or water corresponding to a Hazard Quotient of unity, which is a level thought to be without adverse effect upon long-term exposure (EPA, 1989b; 1991a). The adult receptor is again used for drinking water. For soil, it is assumed that a child ingests 200 mg/day of soil, 350 days per year. Once again, an absorption factor of 1 was assumed.

Selection of Cancer Potency Factors and Reference Doses

Risk-based levels were calculated using EPA-approved cancer potency factors and chronic reference doses applicable to the oral route of exposure. These values were taken from IRIS (EPA, 1991a) and HEAST (EPA, 1991b). When an EPA-approved value could not be located for a particular chemical, a surrogate value was selected by a qualified toxicologist, as described below. The cancer potency values and reference doses used are shown in Table X-44.

For non-carcinogens or substances of unknown carcinogenicity, an EPA-approved chronic oral reference dose for a structurally similar compound was used. Reference doses for fingerprint compounds were derived using data supplied by CIBA-GEIGY. Calculations are shown in footnotes to Table X-44. Values for cobalt and phenacetin were taken from readily available sources. These calculations are also shown in footnotes to Table X-44. If no appropriate value could be located, this is also noted in Table X-44 e.g., there is currently no accepted toxicity value for lead.

If a substance was classified by EPA as an Group A, B, or C carcinogen (EPA, 1991a; 1991b) or classified as a probable carcinogen by the National Toxicology Program (1989), cancer potency factors from close structural analogues were selected as surrogates wherever possible. For a few chemicals generally thought to exert their carcinogenic effect via a direct alkylation of cellular macromolecules (e.g. methyl methanesulfonate), a surrogate value from an appropriate nitrosamine was used. The approximate equipotency of carcinogens acting by direct alkylation is described by Weisburger and Williams (1986). This approximation is adequate and appropriate for screening detection limits. Appropriate values have not yet been identified for four chemicals which are recognized as carcinogens or close analogues of carcinogens by either EPA or the National Toxicology Program: 2-acetylaminofluorene, methapyrilene, 1-naphthylamine, and 2-naphthylamine.

The inhalation slope factor for 1,4-dichloro-2-butene is used as a substitute for the oral cancer slope factor. Because this compound is highly lipid soluble, the absorbed dose for the inhalation and oral routes of exposure is expected to be high and very similar. The liver would be a major site of metabolism by either route of exposure. Since carcinogenicity is related to long-term exposure, the uncertainty presented by using an inhalation slope factor when no oral slope factor is available is certainly less than either using an oral slope factor from another chemical or using no toxicity value at all.

11.4.3 Results

All the cancer potency factors and oral reference doses values employed are presented in Table X-44. Tables X-45 and X-46 present detection limit data for water and for soil and sediment, respectively. These data are arrayed by chemical, showing numbers of samples analyzed, ranges of detection limits, risk-based levels, and, in the case of water, RCRA-recommended sample quantitation limits (EPA, 1991d). Data from groundwater and surface water

collected in Phase I studies are taken together as "water" (Table X-45), while all soils and sediments are taken together (Table X-46). Values for the Pawtuxet River and off-site background samples are included with those from the on-site study areas. This combination was made purely for the purposes of evaluating detection limits. These two areas are not part of the Cranston site and potential health risks associated with them will be assessed separately from any risks associated with the Cranston site.

The Order requires that groundwater be analyzed for the full suite of Appendix IX compounds in Phase II studies. Therefore, a chemical cannot be eliminated from consideration in the PHERE based on detection limits in water. Further, comparison of detection limits in water with RCRA-recommended sample quantitation limits is more properly an issue of data quality to be addressed in the Quality Assurance Plan analytical chemistry in Phase II studies. The remainder of this discussion is concerned with soil and sediment.

Based on the information in Tables X-46, analytes in soil and sediment can be classified into four categories, each of which has a specific implication for whether a chemical should be included as an indicator chemical to be analyzed for in Phase II studies.

Case 1: Maximum Detection Limit < Risk-Based Level

Case 1 is unambiguous. The highest detection limits encountered for 130 chemicals in Phase I studies were lower than concentrations considered to be safe in this very cautious analysis. Therefore, failure to detect any of these chemicals is not likely to have masked an important health risk at the Cranston site.

Case 2: Minimum Detection Limit > Risk-Based Level

Case 2 is also unambiguous. For 23 chemicals the lowest detection limit was higher than the estimated risk-based level. All these will be included as indicator chemicals in Phase II analyses of soil and sediment. The Order already requires analyses for these chemicals in groundwater during Phase II.

A list of Case 2 indicator chemicals was forwarded to the approved analytical laboratories. They responded that with the exception of 2,3,7,8-TCDD, they could reliably detect the compounds at or very close to the risk based level. (Every attempt will be made to reach the lowest feasible detection limits for dioxins/furans.)

The main differences from the above achievable levels and the Practical Quantitation Limits (PQL) in the QA Documents Supplement #2 are the labs would be relying on their method detection limits (MDL) instead of the PQLs. The PQLs have a "safety factor;" they are a multiple of the MDL. The safety factor is to avoid misleading the data user regarding the certainty of the reported value as well as the certainty in the lab's ability to reliably detect the compounds.

The responses from the labs is based upon BEST CASE conditions which include:

- no moisture in the sample since the reported values are based upon dry-weight (The sample-specific reporting limit is directly proportional to the amount of moisture in the sample.)

- the absence of any compound (normal Appendix IX or fingerprint compound and any Tentatively Identified Compound [TIC] above the normal calibration range (The sample-specific reporting limit is directly proportional to the amount of dilution required to quantitate the compound present in the highest concentration.)

In summary, for relatively dry samples without elevated levels of organics present, both approved labs can achieve detection levels within an order of magnitude of the risk-based levels for all the compounds except hexachlorophene. (Hexachlorophene is currently not being reported even though it is an Appendix IX compound. It is light sensitive and cannot be effectively recovered and analyzed. The Quality Assurance Documents: Supplement #2 [Sections 5, page 12] states that we are not reporting the compound.) Under ideal conditions, the risk-based levels can be met for the compounds so identified in the above table.

Case 3: Minimum Detection Limit < Risk-Based Level < Maximum Detection Limit

Ambiguities exist for the 70 chemicals falling into Case 3. For some areas of study, the maximum detection limit could have been lower than the risk-based level, and the chemical would not have been selected as an indicator. High detection limits in other areas could have obscured the presence of some chemicals. Most ambiguities regarding these chemicals are eliminated with an analysis of detection limits on an area-by-area basis, presented in Appendix AA.

Case 4: No Risk-Based Level

Case 4 includes those chemicals for which no cancer potency or reference dose appears in Table X-44. Detection limits need not be considered here for the nutrient metals and chlorinated dioxins and furans for the following reasons:

- The nutrient metals calcium, iron, magnesium, sodium, and potassium were detected in virtually every medium analyzed in Phase I studies (Tables X-1 to X-15). These data are deemed adequate for the purposes of this report, i.e. identifying the detected chemicals. Therefore, risk-based levels are not required.
- Analytical data from Phase I studies were deemed not useful for the tetra-, penta-, and hexachlorinated dibenzo-*p*-dioxins and -dibenzofurans, as discussed in Section 11.2.1 above. Quantitation limits for these substances are listed in the Quality Assurance Plan for Phase II studies. The listed limits are the lowest achievable although they still exceed risk-based levels.
- Dichlorinated and trichlorinated dibenzo-*p*-dioxins and -dibenzofurans are considered to be toxicologically inert by EPA (1989a). The adequacy of the detection limits for these substances is not expected to impact the PHERÉ.

No published toxicity values or appropriate surrogate chemicals could be located for the following semivolatile organic compounds: 2-acetylaminofluorene, bis(2-chloroethoxy)methane, 2,2-oxy-bis(1-chloropropane), methapyrilene, 1-naphthylamine, 2-naphthylamine, and 4-nitroquinoline-N-oxide. Bis(2-chloroethoxy)methane was detected once in AOC-13 groundwater at 1.0 µg/L and 2,2'-oxy-bis(1-chloropropane) was detected twice: in AOC-13 groundwater at 26 µg/L and in SWMU-5 groundwater at 28 ug/L. All seven of these analytes are included in

Appendix IX and will be included as Phase II analytes for groundwater in all areas of study (Table X-77).

In soil and sediment, none of these semivolatile compounds were detected in any area sampled in Phase I. The range of detection limits for soil samples on an area-by area basis is presented in Tables AA-1 through AA-13. From these tables, it can be seen that the range of detection limits for these compounds were within the same order of magnitude as many compounds with published toxicity values determined to belong in Case 1. However, for 4-nitroquinoline-n-oxide, 50 percent or fewer of the samples taken from a given area had usable data reported, with no usable data points reported for this compound in SWMU-10, AAOI-15 or AAOI-16. For these reasons, 4-nitroquinoline-n-oxide will be analyzed for in Phase II.

It should also be noted that no appropriate toxicity value is currently available for lead. Instead of a risk-based level, detection limits were compared to off-site background levels for surface soil.

11.5 SELECTION OF TARGET CHEMICALS

11.5.1 Purpose

Planned sampling and analysis of environmental media for indicator chemicals in Phase II studies will generate adequate data for purposes of the PHERE. CIBA-GEIGY will also be collecting additional samples during Phase II to aid in the definition of the extent of contamination. It is intended that these additional samples will be analyzed for selected chemicals from the Appendix IX list. These selected chemicals are defined as target chemicals and a separate list has been prepared for each area of study and for the Pawtuxet River. This section deals with selection of target chemicals for soils and sediment only, because the Order requires that the two rounds of groundwater sampling in Phase II studies be analyzed for the full list of Appendix IX compounds. "Target chemical" is not a term defined by EPA. It was used in the approved Work Plan to refer to a list of chemicals to be considered as candidates for selection as Constituents of Concern.

It was decided not to include as targets any of the fingerprint compounds or any of the chlorinated dioxins or furans. The fingerprint compounds were generally found at low concentrations and frequencies whenever they were encountered. Also, no EPA-approved toxicological data are available for most of these chemicals. Sampling for chlorinated dioxins and furans was discussed above in Section 11.2.1. These classes of chemicals will be adequately characterized in the sampling and analyses planned for Phase II studies.

11.5.2 Method for Selecting Target Chemicals

Initial Screen

Data for the initial selection process were taken from Tables X-1 through X-15. The essential nutrients calcium, iron, magnesium, potassium, and sodium were eliminated wherever they were encountered, because of their low order of toxicity (EPA, 1989b). Other inorganics were eliminated if the highest concentration detected in soil or sediment in the study area was lower than the highest concentration of that same substance in off-site background soil samples or upstream background sediment samples. (The comparison of maximum detected site

concentrations to maximum measured background results was used for target chemical screening purposes only. In the PHERE, a more thorough statistical approach will be used, such as comparison to a background upper tolerance limit or Student t-test.) Concentrations of the remaining inorganics were then converted to the same units of concentration as the organics ($\mu\text{g/kg}$ of soil or sediment), so proper comparisons could be made. No organic chemicals were eliminated based on background concentrations. The chemicals retained for the concentration/toxicity screen are noted with asterisks in Tables X-1 through X-15.

Among the remaining chemicals in each study area, all carcinogens in class A, B1, or B2 were selected as target chemicals. Class C carcinogens and other remaining compounds were then ranked according to their toxicity and concentration, as described in the approved Work Plan and in EPA risk assessment guidance (EPA, 1989b).

Concentration/Toxicity Rankings

To perform the concentration/toxicity ranking, maximum concentrations of chemicals in soil or sediment in each study area were identified using Tables X-1 through X-15. These values were then divided by the EPA-approved oral reference dose or surrogate value for that chemical shown in Table X-44.

The values for the concentration/toxicity ratio were ranked in descending order. Chemicals yielding a ratio of 1×10^4 or greater (arbitrary units) were designated target chemicals; others were eliminated. By way of orientation, a ratio of 1×10^4 would result if a chemical with a chronic oral reference dose of 0.1 mg/kg-day were present at a concentration of $1000 \mu\text{g/kg}$ of soil or sediment. If a human were to consume 100 mg/day of this soil or sediment containing 1 ppm of this chemical, the resulting hazard quotient would be 0.001 . This demonstrates that a cutoff point of 1×10^4 is not likely to eliminate any substances present at highly toxic levels.

11.5.3 Results

Tables X-47 through X-60 present selection of target chemicals for soils and sediment in the various areas of study on the Cranston site. The target chemicals for sediment in the Pawtuxet River are shown in Table X-61. Fingerprint compounds and chlorinated dioxins and furans were not selected as target compounds, but the maximum observed concentrations of these substances in soil or sediment in Phase I studies is shown in Tables X-47 through X-61. The different areas of study are discussed below.

Some uncertainties exist in the naming of these target chemicals, because of problems with the reliability of the data, as discussed above in Section 11.1.3. The selection process was qualitative in the case of the Class A and B carcinogens and semi-quantitative in the case of Class C carcinogens and other chemicals. The data used are considered qualitatively reliable, so the selection process for Class A and B carcinogens is not likely to result in underestimation of carcinogenic risk. Using the cut-off point of 1×10^4 for Class C carcinogens and other chemicals insures that the indicator chemicals are those that present the greatest portion of any significant non-carcinogenic risk which might exist if exposure to soil or sediment from a study area were to occur.

The discussion below is arranged area by area. Target chemicals are described according to the analytical fractions which must be run to detect them in Phase II studies. Inorganic target

chemicals are named individually. Class A or B carcinogens are discussed separately from other compounds.

Production Area

SWMU-2. Just 6 target chemicals were selected for soils in SWMU-2 (Table X-47), including carcinogenic organochlorine insecticides, PCB-1254 (also known as "Arochlor-1254"), an organophosphorus insecticide, and semi-volatile organic compounds.

SWMU-3. Sixteen target chemicals were selected for soils in SWMU-3 (Table X-48). The carcinogens included organochlorine insecticides, PAHs, and 1,4-dioxane. The other chemicals included PCB-1254, organophosphorus pesticides, volatiles, and semi-volatiles.

SWMU-7. Twenty-five target chemicals were selected for SWMU-7 (Table X-49). The carcinogens included organochlorine insecticides, PCB-1260, and styrene. The other chemicals included PCB-1254, organophosphorus insecticides, volatiles, and semi-volatiles.

SWMU-8. Table X-50 shows the 26 target chemicals selected for soils in SWMU-8. The carcinogens in this group included PAHs and organochlorine insecticides. The other chemicals included PCB-1254, organochlorine insecticides, organophosphorus pesticides, volatiles, semi-volatiles, and zinc.

SWMU-11. Twenty-eight target chemicals were selected for soils in SWMU-11 (Table X-51). The carcinogens were comprised of PAHs and organochlorine pesticides. The other target chemicals included PCB-1254, organochlorine insecticides, an organophosphorus insecticide, volatiles, semi-volatiles, an herbicide, and mercury.

AOC-13. Forty target chemicals were selected for soil in AOC-13 (Table X-52). This was the largest number of target chemicals of any study area in the Production Area. The carcinogens selected included PAHs, organochlorine insecticides, semi-volatile organics, and arsenic. The other chemicals included PCB-1254, organochlorine insecticides, organophosphorus insecticides, volatiles, semi-volatiles, and inorganics: cadmium, copper, cyanide, nickel, and vanadium.

AAOI-15. Twenty target chemicals were selected for soils in AAOI-15 (Table X-53). The carcinogens included PAHs, organochlorine insecticides, and beryllium. The other target chemicals included organochlorine insecticides, an organophosphorus insecticide, and semi-volatile organic compounds.

Warwick Area

SWMU-5. Table X-54 presents the selection of 55 target chemicals from soils in SWMU-5. The carcinogens include organochlorine insecticides, PAHs, semi-volatile organic compounds, and beryllium. The other target chemicals include PCBs, organochlorine insecticides, organophosphorus insecticides, volatiles, semi-volatiles, herbicides, and inorganics: antimony, barium, cadmium, chromium, copper, cyanide, mercury, nickel, and zinc.

SWMU-6. Eleven target chemicals were selected for soils in SWMU-6 (Table X-55). The carcinogens were all organochlorine insecticides. The other chemicals consisted of PCB-1254, organochlorine insecticides, a semi-volatile, and the inorganics cadmium and zinc.

SWMU-9. Seventeen target chemicals were selected for soils in SWMU-9 (Table X-56). The carcinogens included organochlorine insecticides and semi-volatile organics. The other target chemicals consisted of PCB-1254, organochlorine insecticides, an organophosphorus insecticide, and semi-volatiles.

AAOI-16. Just 3 target chemicals were selected for soils in AAOI-16 (Table X-57). The one carcinogen selected was an organochlorine insecticide. The other target chemicals were PCB-1254 and another organochlorine insecticide.

Waste Water Treatment Area

SWMU-10. Nine target chemicals were selected for soils in SWMU-10 (Table X-58). The carcinogens selected include organochlorine insecticides and a semi-volatile compound. The other chemicals consisted of PCB-1254, an organochlorine insecticide, organophosphorus insecticides, and silver.

SWMU-12. Table X-59 presents the 40 target chemicals selected for soils in SWMU-12. The carcinogens consist of organochlorine insecticides and PAHs, which are analyzed with the semi-volatile fraction. The other chemicals consisted of PCB-1254, organochlorine insecticides, organophosphorus insecticides, volatiles, semi-volatiles, and metals: copper, silver, and zinc.

WWTA (SWMU-10) Pond. A total of 15 target chemicals were selected for sediments in the pond in the Waste Water Treatment Area (Table X-60). The carcinogens consisted of organochlorine insecticides and semi-volatile chemicals, including PAHs. The other target chemicals selected included organochlorine insecticides, volatile, and semi-volatiles organics, and thallium.

Off-Site Areas

Pawtuxet River. Table X-61 shows the 68 target chemicals selected for sediments from the Pawtuxet River. The carcinogens selected as target chemicals included organochlorine insecticides, semi-volatiles, and inorganics: arsenic, beryllium, and lead. The remaining target chemicals included PCBs, organochlorine insecticides, organophosphorus insecticides, herbicides, volatiles, semi-volatiles, and inorganics: barium, cadmium, chromium, cobalt, copper, cyanide, manganese, mercury, nickel, selenium, silver, thallium, tin, vanadium, and zinc.

11.6 SUMMARY

An overview of the selection process for indicator and target chemicals is presented in Table 11-1. Analytes are identified as indicator chemicals in three different areas of this chapter: Section 11.2 on chemicals detected and identified; Section 11.3 on chemicals tentatively identified; and Section 11.4 on chemicals whose detection limits were higher than risk-based concentrations. These three sources are compiled into lists of indicator chemicals in Tables X-62 through X-77 for each medium in each area of study. Note that all chlorinated biphenyls, either identified chemicals or TICs, are referred to collectively as PCBs. Tetra-, penta-, and hexachlorinated dibenzo-*p*-dioxins and -dibenzofurans are listed as PCDDs and PCDFs and will be analyzed for in all media and areas of study in Phase II.

Indicator Compounds

The chemicals on these lists will be analyzed for in Phase II studies and will be assessed for potential health and environmental risks in the PHERE. Changes to the lists of chemicals shown in Tables X-62 through X-77 will be presented in the Quality Assurance Plan for Phase II studies, following resolution of certain ambiguities described in Section 11.4.

Some samples of surface water, sediment, and soils will be analyzed for target chemicals, which are a subset of the indicator chemicals for medium and area of study. Target chemicals are shown in Tables X-47 through X-61.

**TABLE 11-1: OVERVIEW OF INDICATOR AND TARGET CHEMICAL
SELECTION FOR SOIL, SEDIMENT AND SURFACE WATER**

Type of analytical result	Criteria for selecting indicator chemicals (a)	Criteria for selecting target chemicals (from list of indicator chemicals) (b)
positively identified inorganic analytes (c)	<ul style="list-style-type: none"> positively detected 	<ul style="list-style-type: none"> soil concentration detected above off-site (background) soil concentration sediment concentration detected above upstream sediment concentration Class A, B1 or B2 carcinogen concentration toxicity screen value above 1×10^4 (unitless ratio) not an essential nutrient (calcium, iron, magnesium, potassium and sodium not selected)
positively identified organic analytes (c)	<ul style="list-style-type: none"> positively detected 	<ul style="list-style-type: none"> Class A, B1 or B2 carcinogen concentration toxicity screen value above 1×10^4 (unitless ratio) not an essential nutrient (calcium, iron, magnesium, potassium and sodium not selected)
fingerprint compounds (c)	<ul style="list-style-type: none"> positively detected 	<ul style="list-style-type: none"> none selected
chlorinated dioxins/furans (d)	<ul style="list-style-type: none"> all tetra-, penta-, and hexa-chlorinated dioxins and dibenzofurans 	<ul style="list-style-type: none"> none selected
nondetected inorganic or organic analytes (d)	<ul style="list-style-type: none"> lowest detection limit higher than risk-based level ("Case 2") 	<ul style="list-style-type: none"> none selected
tentatively identified compounds (TICs) (e)	<ul style="list-style-type: none"> potentially toxic compound with a recognizable chemical name (e.g. "unknown_3" not selected), and: detected more than once in an area of study Class A, B or C carcinogen concentration above 1000 ppb, or detected in both media within an area of study 	<ul style="list-style-type: none"> none selected

- (a) indicator chemicals for Phase II are selected to generate adequate data for the PHERE
- (b) target chemicals, a subset of the indicator chemicals, are selected for analysis in Phase II to aid in the definition of the extent of contamination
- (c) selected on an area-by-area basis
- (d) selected on a site-wide basis
- (e) selected first on a site-wide basis, then screened further on an area-by-area basis

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Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
PRODUCTION	SWMU-2	Soil	B-2E	Split Spoon	Grab	0-8 ft) 2 Indicator, 5 Target)
		Soil	B-2F	Split Spoon	Grab	0-8 ft	
		Soil	B-2G	Split Spoon	Grab	0-8 ft	
		Groundwater	MW-10S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-10D	Bailer	Grab	35-45 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-2F	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
PRODUCTION	SWMU-3	Soil	B-3E	Split Spoon	Grab	0-8 ft) 2 Indicator, 9 Target))))
		Soil	B-3F	Split Spoon	Grab	0-8 ft	
		Soil	B-3G	Split Spoon	Grab	0-8 ft	
		Soil	B-3H	Split Spoon	Grab	0-8 ft	
		Soil	B-3I	Split Spoon	Grab	0-8 ft	
		Groundwater	MW-12S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-12D	Bailer	Grab	35-45 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-13S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-13D**	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-33S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	RC-1**	Bailer	Grab	8-40 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-3I***	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	MW-13D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	P-32D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
PRODUCTION	SWMU-7	Soil	B-7D	Split Spoon	Grab	0-8 ft) 2 Indicator, 9 Target))))
		Soil	B-7E	Split Spoon	Grab	0-8 ft	
		Soil	B-7F	Split Spoon	Grab	0-8 ft	
		Soil	B-7G	Split Spoon	Grab	0-8 ft	
		Soil	B-7H	Split Spoon	Grab	0-8 ft	
		Groundwater	Same as SWMU-3				
PRODUCTION	SWMU-7 (cont)	Groundwater	B-7I***	Hydropunch	In-situ	8-13 ft	Appendix IX VOA

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
PRODUCTION	SWMU-8	Soil	B-8D	Split Spoon	Grab	0-8 ft)
		Soil	B-8E	Split Spoon	Grab	0-8 ft)
		Soil	B-8F	Split Spoon	Grab	0-8 ft) 2 Indicator, 9 Target
		Soil	B-8G	Split Spoon	Grab	0-8 ft)
		Soil	B-8H	Split Spoon	Grab	0-8 ft)
		Groundwater	MW-13S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-13D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-33S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	RC-1**	Bailer	Grab	8-40 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-8H***	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	MW-13D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	P-32D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
PRODUCTION	SWMU-11	Soil	B-11D	Split Spoon	Grab	0-8 ft)
		Soil	B-11E	Split Spoon	Grab	0-8 ft)
		Soil	B-11F	Split Spoon	Grab	0-8 ft)
		Soil	B-11G	Split Spoon	Grab	0-8 ft)
		Soil	B-11H	Split Spoon	Grab	0-8 ft) 4 Indicator, 18 Target
		Soil	B-11I	Split Spoon	Grab	0-8 ft)
		Soil	B-11J	Split Spoon	Grab	0-8 ft)
		Soil	B-11K	Split Spoon	Grab	0-8 ft)
		Soil	B-11L	Split Spoon	Grab	0-8 ft)
		Soil	B-11M	Split Spoon	Grab	0-8 ft)
	SWMU-11 (cont)	Groundwater	MW-4S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-4D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-14S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-14D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-21S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-34S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
PRODUCTION		Groundwater	MW-34D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	RC-2**	Bailer	Grab	8-40 ft	Appendix IX, Fingerprint, Treatability*

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
		Groundwater	B-11L***	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-11M***	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	MW-4D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	MW-14D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	MW-34D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	P-33D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
PRODUCTION	AOC-13	Soil	B-2E	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-2F	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-2G	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-3E	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-3F	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-3G	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-3H	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-3I	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-7D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-7E	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-7F	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-7G	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-7H	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-8D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-8E	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-8F	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-8G	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-8H	Split Spoon	Grab	2-8 ft	PCB(e)
PRODUCTION	AOC-13 (cont)	Soil	B-11D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11E	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11F	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11G	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11H	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11I	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11J	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11K	Split Spoon	Grab	2-8 ft	PCB(e)

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
PRODUCTION	AOC-13 (cont)	Soil	B-11L	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	B-11M	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-2D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-4D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-13D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-14D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-20S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-21S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-22S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-23S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-24S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-33S	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	MW-34D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	P-32D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	P-33D	Split Spoon	Grab	2-8 ft	PCB(e)
		Soil	SF-B2	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-B7	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-C20	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-D37	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-E23	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-E31	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-E34	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-G18	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-G26	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-G38	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-H14	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-I11	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-I21	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-I43	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-J45	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-K26	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-L6	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-L16	Trowel	Grab	6-12 inches	PCB(l)
		Soil	SF-L48	Trowel	Grab	6-12 inches	PCB(l)

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
PRODUCTION	AOC-13 (cont)	Soil	SF-M21	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-M42	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-N13	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-N29	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-N34	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-O7	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-O17	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-O44	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Q22	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Q38	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Q42	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-R12	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-R31	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-S15	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-S34	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-T20	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-U17	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-U27	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-U37	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-V23	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-W13	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-W32	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Y21	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Z15	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-Z28	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AA19	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AB23	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AD27	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AE11	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AG23	Trowel	Grab	6-12 inches	PCB(I)
		Soil	SF-AJ15	Trowel	Grab	6-12 inches	PCB
		Groundwater	MW-1S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-1D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
PRODUCTION	AOC-13 (cont)	Groundwater	MW-2S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-2D	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-3S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-4S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-4D**	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-5SA**	Bailer	Grab	10-20 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-10S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-10D**	Bailer	Grab	35-45 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-12S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-12D**	Bailer	Grab	35-45 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-13S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-13D**	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-14S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-14D**	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-20S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-21S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-22S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-23S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-24S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-33S	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-34S**	Bailer	Grab	8-18 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-34D**	Bailer	Grab	40-50 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	RC-1	Bailer	Grab	8-40 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	RC-2	Bailer	Grab	8-40 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-2G**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-3I**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-7H**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-8H**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-11L**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	B-11M**	Hydropunch	In-situ	8-13 ft	Appendix IX VOA
		Groundwater	MW-2D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	MW-4D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	MW-13D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	MW-14D**	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
		Groundwater	MW-34D **	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	P-32D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
		Groundwater	P-33D	Hydropunch	In-situ	8-13, 23-28, 38-43 ft	Appendix IX VOA
WASTE WATER TREATMENT	SWMU-10	Soil	B-10F	Split Spoon	Grab	0-4 ft)
		Soil	B-10G	Split Spoon	Grab	0-4 ft)
		Soil	B-10H	Split Spoon	Grab	0-4 ft)
	SWMU-10 (cont)	Groundwater	MW-9S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*
WASTE WATER TREATMENT		Sediment	SD-02P	Ponar	Grab	0-6 inches	Indicator Compounds
		Sediment	SD-03P	Ponar	Grab	0-6 inches	Indicator Compounds
		Surface Water	SW-02P	Dip	Grab	Dip	Appendix IX, Fingerprint, Treatability*
WASTE WATER TREATMENT	SWMU-12	Soil	B-12A	Split Spoon	Grab	0-4 ft)
		Soil	B-12B	Split Spoon	Grab	0-4 ft)
		Soil	B-12C	Split Spoon	Grab	0-4 ft) 2 Indicator, 9 Target
		Soil	B-12D	Split Spoon	Grab	0-4 ft)
		Soil	B-12E	Split Spoon	Grab	0-4 ft)
		Groundwater	MW-7S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-8S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-15S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-25S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-12F	Hydropunch	In-situ	5-10 ft	Appendix IX VOA
		Groundwater	B-12G	Hydropunch	In-situ	5-10 ft	Appendix IX VOA
WARWICK	SWMU-5	Soil	B-5A	Split Spoon	Grab	0-5 ft)
		Soil	B-5B	Split Spoon	Grab	0-5 ft)
		Soil	B-5C	Split Spoon	Grab	0-5 ft) 2 Indicator, 11 Target
		Soil	B-5D	Split Spoon	Grab	0-5 ft)
		Soil	B-5E	Split Spoon	Grab	0-5 ft)

Table 15-2. Proposed Phase II Release Characterization Sampling Program (1)

Area	Location	Media	Sample Identification	Sampling Method	Sample Type	Sample Depth	Analyses
WARWICK	SWMU-5 (cont)	Soil	B-5F	Split Spoon	Grab	0-5 ft)
		Groundwater	MW-6S	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-11S	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-11D	Bailer	Grab	30-40 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	MW-26S	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-5G	Hydropunch	In-situ	5-10 ft	Appendix IX VOA
		Groundwater	B-5H	Hydropunch	In-situ	5-10 ft	Appendix IX VOA
		Groundwater	MW-11D	Hydropunch	In-situ	5-10, 20-25, 35-40 ft	Appendix IX VOA
WARWICK	SWMU-9	Soil	B-9A	Split Spoon	Grab	2-4 ft	Indicator Compounds
		Soil	B-9B	Split Spoon	Grab	2-4 ft	Indicator Compounds
WARWICK	SWMU-16	Soil	B-16B	Split Spoon	Grab	2-4 ft	Indicator Compounds
		Soil	B-16C	Split Spoon	Grab	2-4 ft	Indicator Compounds
		Soil	B-16D	Split Spoon	Grab	2-4 ft	Indicator Compounds
		Groundwater	MW-17S	Bailer	Grab	6-16 ft	Appendix IX, Fingerprint, Treatability*
		Groundwater	B-16E	Hydropunch	In-situ	6-11 ft	Appendix IX VOA
		Groundwater	B-16F	Hydropunch	In-situ	6-11 ft	Appendix IX VOA
		Groundwater	MW-32S	Bailer	Grab	4-14 ft	Appendix IX, Fingerprint, Treatability*

(1) Sampling Program for Round 1, much of the Round 2 sampling requires review of Round 1 Results

*Treatability parameters include major ions and physiochemical parameters

** Secondary Well

*** Assumes this is the furthest downgradient boring from the SWMU

PCB(I) Laboratory-grade PCB Analysis (Level IV)

PCB(e) Engineering-grade PCB Analysis (Level II)

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PHASE II OFF-SITE INVESTIGATION PROPOSAL

16.1 OVERVIEW

This chapter proposes a work plan for the Phase II off-site investigation in this RCRA Facility Investigation. Two separate investigations will be conducted as part of the Phase II off-site investigation — a *background* investigation (similar to the Phase I background investigation proposed by CIBA-GEIGY to determine “background”, or previously existing, levels of compounds) and an *additional off-site* investigation (required by the Order at specified locations). In general, the objectives of these two off-site investigations are:

- determining the nature, concentration, and extent of various compounds detected at background locations (which will serve as regional baselines for compounds); and
- determining the nature, concentration, and extent of various compounds detected at additional off-site locations specified in the Order (if any).

At the conclusion of Phase II, the results from the physical characterization, the release characterization, and the off-site investigation will be reviewed and a strategy for the Corrective Measures Study will be developed.

Table 16-1 outlines the proposal for the Phase II off-site investigation. It summarizes the work proposed for the Phase II background investigation and additional off-site investigations including:

- the *data gaps* identified in Phase I (or other *data needs* for Phase II);
- the *strategies* proposed to fill those data gaps or data needs;
- the *activities* proposed to implement those strategies; and
- any *contingencies* that could impact the activities proposed.

This chapter is organized around Table 16-1 — Section 16.2 discusses the Phase II background investigation and Section 16.3 discusses the Phase II additional off-site investigation. In each of these sections, first the results obtained and the data gaps/needs identified from the corresponding Phase I investigation are reviewed; then the strategies and activities proposed for Phase II are presented. Finally, integration of each investigation with the other Phase II studies, and any contingencies for the activities proposed, are discussed. The chapter concludes with an overall summary.

16.2 PHASE II BACKGROUND INVESTIGATION

This section summarizes the results from, and the data gaps identified in, the Phase I background investigation. It also presents the strategy proposed for Phase II to fill those data gaps, as well as methods and analyses proposed to implement the Phase II strategy.

16.2.1 Summary of the Phase I Results for the Background Investigation

The Phase I background investigation examined both soil and groundwater; the results are summarized here for both Media of Concern. The concentrations of inorganic analytes detected in

the background soil samples were used as the baselines for inorganics. This summary only lists the inorganics detected in groundwater samples at concentrations exceeding the baseline levels; the number of samples in which an inorganic analyte exceeded the baseline is shown in parentheses. (The baseline concentrations for inorganic analytes in soils were presented in Table 6-1 and discussed in Chapter 10; the baselines for groundwater are MCLs and secondary drinking water standards.) The results for groundwater samples from the overburden and bedrock aquifers are presented separately. The summary includes these parameters:

- *Number of Analytes Detected* indicates, across all samples, the minimum and maximum number of analytes from that fraction that were detected in the samples.
- *Minimum and Maximum Detected Concentrations* indicates the minimum and maximum concentrations detected across all analytes detected in all samples. ("ND" means not detected.)
- *Range of Total Concentrations* indicates, across all samples, the minimum and maximum total concentrations for that fraction.
- *Mean Total Concentration* indicates the average of the total concentrations for that fraction, across all samples.
- *Median Total Concentration* indicates the median of the total concentrations for that fraction, across all samples.

Soil. The following results were obtained for the eight soil samples from the four background locations. (Inorganic results were used to determine baselines.)

Fraction	Number of Analytes Detected	Minimum and Maximum Detected Concentrations (ppm)	Range of Total Concentr'ns (ppm)	Mean Total Concentr'n (ppm)	Med'n Total Concentr'n (ppm)
VOCs	1 - 3	0.026 - 1.2	0.026 - 1.2	0.27	0.14
Semi-Volatiles	3 - 18	0.023 - 69	0.25 - 428	69	7.5
PCBs	0 - 0	—	—	—	—
Dioxins/Furans	0 - 0	—	—	—	—
Pesticides/Herbicides	2 - 5	0.00027 - 0.38	0.0049 - 0.64	0.18	0.04

Groundwater (Overburden Aquifer). The following results were obtained for the four groundwater samples from the overburden aquifer at two background locations.

Fraction	Number of Analytes Detected	Minimum and Maximum Detected Concentrations (ppb)	Range of Total Concentr'ns (ppb)	Mean Total Concentr'n (ppb)	Med'n Total Concentr'n (ppb)
VOCs	0 - 0	—	—	—	—
Semi-Volatiles	0 - 3	1 - 3	ND - 7	2	0.5
PCBs	0 - 0	—	—	—	—
Dioxins/Furans	0 - 0	—	—	—	—
Pesticides/Herbicides	0 - 3	0.0081 - 0.063	ND - 0.121	0.04	0.02
Metals/Cyanide	Total metals exceeding baselines: arsenic (2), chromium (4), iron (4), manganese (4) Dissolved metals exceeding baselines: manganese (4)				

Groundwater (Bedrock Aquifer). The following results were obtained for the two groundwater samples from the bedrock aquifer at one background location (RW-4).

<u>Fraction</u>	<u>Number of Analytes Detected</u>	<u>Minimum and Maximum Detected Concentrations (ppb)</u>	<u>Range of Total Concentrations (ppb)</u>	<u>Mean Total Concentration (ppb)</u>	<u>Median Total Concentration (ppb)</u>
VOCs	0 – 1	3.5 – 3.5	ND – 3.5	1.75	1.75
Semi-Volatiles	0 – 0	—	—	—	—
PCBs	0 – 0	—	—	—	—
Dioxins/Furans	0 – 0	—	—	—	—
Pesticides/Herbicides	0 – 2	0.0041 – 0.013	ND – 0.0171	0.0086	0.0086
Metals/Cyanide	Total metals exceeding baselines: iron (2), manganese (2) Dissolved metals exceeding baselines: iron (2), manganese (2)				

16.2.2 Phase I Data Gaps/Phase II Data Needs at Background Locations

The Phase I background investigation identified four data gaps or data needs:

- The background surficial soil results need re-verification.
- The background conditions of the surficial and subsurface soils need to be evaluated.
- The background groundwater results need re-verification.
- The background chemistry of groundwater entering the Production and Warwick areas needs to be evaluated.

Objectives of the Phase II Background Investigation

The objectives of the Phase II background investigation are to fill these data gaps/data needs. The Phase II background investigation will confirm the Phase I results for surficial soils and will compare the analytical results for subsurface samples collected in background locations to the results for subsurface samples collected in areas potentially impacted by known or suspected releases from the facility. The Phase II background investigation also will confirm the Phase I results for groundwater samples, will evaluate the groundwater upgradient of the Production and Warwick areas, and will compare the analytical results for groundwater from Phase I background locations to the results for groundwater collected in areas potentially impacted by known or suspected releases from the facility. In general, the background data will be used to define more completely the regional frame of reference for the concentrations of both naturally occurring chemicals (e.g., metals) and man-made chemicals.

Media of Concern for the Phase II Background Investigation

The same two Media of Concern investigated in Phase I — soil and groundwater — will be investigated in Phase II. (Groundwater was not specified in the Order, but is included for completeness of the study.) Two sampling rounds will be performed for the Media of Concern.

16.2.3 Strategy for the Phase II Background Investigation

The strategy for the Phase II background investigation is:

- Resample selected Phase I background surficial soil locations.
- Sample the surficial and subsurface soils from new background locations.
- Resample groundwater at existing background monitoring wells.
- Sample groundwater at new background monitoring wells.

16.2.4 Methods and Analyses for the Phase II Background Investigation

Soil samples will be collected from both surficial excavations and subsurface borings; groundwater samples will be collected from monitoring wells. Table 16-2 summarizes the sampling to be conducted for the Phase II background investigation.

Surficial Soil. Surficial soil sampling for the Phase II background investigation will be conducted at two of the four locations sampled in Phase I — Belmont Park and Wyman School — and at two new locations — a residence near the Cranston City Hall Annex and the Warwick Boy's and Girl's Club. In Round 1, a soil sample will be collected from a depth of 6 to 12 inches at each background location. In Round 2, another surficial soil sample will be collected at each location. All eight surficial soil samples will be analyzed for Appendix IX and fingerprint compounds.

Subsurface Soil. In Round 1, four borings will be advanced at background locations (shown in Figure 16-1) to collect subsurface soil samples from just above the water table. In two of these borings, monitoring wells (MW-27S and MW-28S) upgradient of the Warwick Area will be installed. One other boring (MW-35S) will be used to install a monitoring well upgradient of the Production Area. The fourth boring will be advanced adjacent to bedrock well RW-4 (a Phase I background location). Note that, although all four borings are located within the facility boundary, they have been positioned in areas considered not to have been impacted by CIBA-GEIGY activities and, thus, serve as background locations. One sample will be collected from each boring. In Round 2, four more borings will be advanced at these background locations (adjacent to the borings advanced in Round 1). One sample will be collected from each Round 2 boring to verify the results from the first sampling round. All eight subsurface soil samples will be analyzed for Appendix IX and fingerprint compounds.

Groundwater. Groundwater samples will be collected from two existing upgradient monitoring wells (MW-18S and MW-19S) to verify the results from Phase I, and from three newly installed monitoring wells (MW-27S, MW-28S, and MW-35S) upgradient of the Production and Warwick areas to provide data about the groundwater entering the site. All five well locations are shown in Figure 16-1. In Round 1, one groundwater sample will be collected from each well. In Round 2, each well will be resampled to verify the analytical results from the first sampling round and to evaluate the effect of seasonality on the groundwater. All ten samples will be analyzed for Appendix IX and fingerprint compounds.

Details about the soil sampling, well installation, and groundwater sampling methodologies were presented in the Quality Assurance Documents, Volume 2 of the RCRA Facility Investigation Proposal.

16.2.5 Considerations for the Phase II Background Investigation

Other considerations for the Phase II background investigation — including integration of the background data with other Phase II studies as well as contingencies for the Phase II background investigation — are discussed here.

Integration with Other Phase II Studies

The data from the Phase II background investigation of soils will be used to define more completely the regional frame of reference for the concentrations of both naturally occurring chemicals (e.g., metals) and man-made chemicals.

Contingencies for the Phase II Background Investigation

There are no contingencies for the activities proposed in the Phase II background investigation.

16.2.6 Summary of the Phase II Background Investigation

The Phase II background investigation will investigate soil and groundwater at locations investigated in Phase I, subsurface soils at four background locations, and groundwater entering the Production and Warwick areas from upgradient locations. The Phase II background investigation of soils will be used to confirm the Phase I results for surficial soils and to compare the analytical results for subsurface background soils to the results for subsurface soil samples from areas potentially impacted by known or suspected releases (if any). The Phase II background investigation of groundwater will be used to confirm the Phase I results for groundwater and to compare the analytical results for groundwater from Phase I background locations to the results for groundwater samples collected in areas potentially impacted by known or suspected releases.

16.3 PHASE II ADDITIONAL OFF-SITE INVESTIGATION

This section summarizes the results from, and the data gaps identified in, the Phase I additional off-site investigation. It also presents the strategy proposed for Phase II to fill those data gaps, as well as methods and analyses proposed to implement the Phase II strategy.

16.3.1 Summary of the Phase I Results for the Additional Off-Site Investigation

The Phase I additional off-site investigation examined only one Medium of Concern — soil; the results are summarized here.

Soil. The following results were obtained for the fourteen surficial soil samples from the additional off-site locations.

<u>Fraction</u>	<u>Number of Analytes Detected</u>	<u>Minimum and Maximum Detected Concentrations (ppm)</u>	<u>Range of Total Concentr'ns (ppm)</u>	<u>Mean Total Concentr'n (ppm)</u>	<u>Med'n Total Concentr'n (ppm)</u>
VOCs	1 – 3	0.023 – 7	0.023 – 7.35	0.78	0.27
Semi-Volatiles	1 – 18	0.013 – 4.1	0.057 – 26.52	6	2
PCBs	0 – 1	0.16 – 0.16	ND – 0.16	0.011	ND
Dioxins/Furans	0 – 0	—	—	—	—
Pesticides/Herbicides	0 – 7	0.00022 – 0.93	ND – 1.5	0.2	0.03
Metals/Cyanide	The following exceeded baselines: arsenic (1), calcium (2), chromium (1), copper (2), lead (1), sodium (2), vanadium (1)				

16.3.2 Phase I Data Gaps/Phase II Data Needs at Additional Off-Site Locations

The Phase I additional off-site investigation identified two data gaps:

- The results for the soil samples from the additional off-site locations need to be verified in Phase II.
- Soil from new locations needs to be sampled.

Objective of the Phase II Additional Off-Site Investigation

The objective of the Phase II additional off-site investigation is to fill these data gaps. The Phase II additional off-site investigation will determine whether compounds detected in the samples collected on-site are detected off-site as well.

Media of Concern for the Phase II Additional Off-Site Investigation

Soil will be evaluated in the Phase II additional off-site investigation; two rounds of sampling will be conducted.

16.3.3 Strategy for the Phase II Additional Off-Site Investigation

The strategy for the Phase II additional off-site investigation is to sample surficial soil from the fourteen additional off-site locations (eleven in Round 1 and three in Round 2), and from five new locations.

16.3.4 Methods and Analyses for the Phase II Additional Off-Site Investigation

Soil samples will be collected from surficial excavations. Table 16-2 summarizes the sampling to be conducted for the Phase II additional off-site investigation.

The eleven locations (specified in the Order) sampled in Phase I will be resampled in the Phase II additional off-site investigation. These locations were shown in Figure 10-5. Five new locations have been included for completeness of the study. In Round 1, sixteen surficial soil samples (collected from a depth of 6 to 12 inches) will be analyzed for Appendix IX and fingerprint compounds. In Round 2, surficial soil from the five new locations sampled in Phase II and from the three locations sampled in Phase I, Round 2 (but not in Phase II, Round 1) will be sampled. These eight samples also will be analyzed for Appendix IX and fingerprint compounds. (Details about the soil sampling methodology were presented in the Quality Assurance Documents.)

16.3.5 Considerations for the Phase II Additional Off-Site Investigation

Other considerations for the Phase II additional off-site investigation — including integration of the off-site data with other Phase II studies as well as contingencies for the Phase II additional off-site investigation — are discussed here.

Integration with Other Phase II Studies

The data from both the Phase I and Phase II additional off-site investigations will be compared with the data from the Phase II release characterizations to determine whether compounds detected in the samples collected on-site are detected off-site as well.

Contingencies for the Phase II Additional Off-Site Investigation

There are no contingencies for the activities proposed in the Phase II additional off-site investigation.

16.3.6 Summary of the Phase II Additional Off-Site Investigation

In Round 1, the Phase II additional off-site investigation will sample surficial soil at eleven of the fourteen locations sampled in Phase I and at five new locations. These sixteen samples will be analyzed for Appendix IX and fingerprint compounds. In Round 2, surficial soil from the five new locations sampled in Phase II and from the three locations sampled in Phase I, Round 2 (but not in Phase II, Round 1) will be sampled. These eight samples also will be analyzed for Appendix IX and fingerprint compounds. The data will be used to determine whether compounds detected in the samples collected on-site are detected off-site as well.

16.4 SUMMARY

This chapter described the two investigations proposed for the Phase II off-site investigation.

The *Phase II background investigation* will investigate soil and groundwater at locations investigated in Phase I, subsurface soils at four background locations, and upgradient groundwater entering the Production and Warwick areas. The Phase II background investigation of soils will be used to confirm the Phase I results and to compare the results for subsurface background soils to the results for subsurface soil samples from areas potentially impacted by known or suspected releases. The Phase II background investigation of groundwater will be used to confirm the Phase I results for groundwater and to compare the results for groundwater from Phase I background locations to the results for groundwater from areas potentially impacted by known or suspected releases.

The *Phase II additional off-site investigation* will sample (in Round 1) surficial soil at eleven of the fourteen locations sampled in Phase I and at five new locations. In Round 2, soil from the other three Phase I locations and from the five new Phase II locations will be sampled. All sixteen Round 1 samples and all 8 Round 2 samples will be analyzed for Appendix IX and fingerprint compounds. The data will be used to determine if compounds detected on-site are detected off-site as well.

The next chapter presents a preliminary evaluation of corrective measures based on the Phase I results and the work proposed for Phase II of this Facility Investigation.

Table 16-1. Outline of the Phase II Off-Site Investigation Proposal

<u>Location</u>	<u>Data Gaps/Needs</u>	<u>Strategy</u>	<u>Activities Proposed</u>	<u>Contingency</u>
<i>Background Locations</i>	Re-verify Phase I soil results	Resample surficial soil	collect surficial samples at 2 locations 2 sampling rounds 1 sample/location/round analyze for App IX & fingerprt cmpds	
	Evaluate surficial background soil	Sample surficial soil	collect surficial samples at 2 new locations 2 sampling rounds 1 sample/location/round analyze for App IX & fingerprt cmpds	
	Evaluate subsurface background soil	Sample subsurface soil	advance borings at 4 locations collect subsurface samples 2 sampling rounds 1 sample/location/round analyze for App IX & fingerprt cmpds	
	Re-verify Phase I groundwater results	Resample groundwater	at 2 existing background wells wells MW-18S & -19S upgradient of Prod./WWT areas 2 sampling rounds analyze for App IX & fingerprt cmpds	
	Evaluate groundwater into Production & Warwick areas	Sample groundwater at new wells	at 3 new background wells wells MW-27S, -28S, & -35S upgradient of Production & Warwick areas 2 sampling rounds analyze for App IX & fingerprt cmpds	
<i>Additional Locations</i>	Verify Phase I results	Resample surficial soil	collect surficial samples at 16 locations (Rnd 1) collect surficial samples at 8 locations (Rnd 2) 1 sample/location/round analyze Rnds 1 & 2 (all off-site locations) for App IX & fingerprt cmpds	

Table 16-2. Proposed Phase II Background/Off-site Sampling Program

Area	Location	Media	Sampling Method	Sample Type	Sample Depth	Phase II Analyses
Background	Belmont Park	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Warwick Boys' & Girls' Club	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Residence Near Cranston City Hall Annex	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Wyman School	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	B-BGA	Soil	Split Spoon	Grab	10-12 ft	Appendix IX, Fingerprint Compounds
	B-BGB	Soil	Split Spoon	Grab	10-12 ft	Appendix IX, Fingerprint Compounds
	B-BGC	Soil	Split Spoon	Grab	3-5 ft	Appendix IX, Fingerprint Compounds
	B-BGD	Soil	Split Spoon	Grab	3-5 ft	Appendix IX, Fingerprint Compounds
	MW-18S	Groundwater	Bailer	Grab	18-28 ft	Appendix IX, Fingerprint, Treatability*
	MW-19S	Groundwater	Bailer	Grab	16-26 ft	Appendix IX, Fingerprint, Treatability*
	MW-27S	Groundwater	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*
	MW-28S	Groundwater	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*
	MW-35S	Groundwater	Bailer	Grab	5-15 ft	Appendix IX, Fingerprint, Treatability*

* Treatability Parameters include major ions and physiochemical parameters

Table 16-2. Proposed Phase II Background/Off-site Sampling Program

Area	Location	Media	Sampling Method	Sample Type	Sample Depth	Phase II Analyses
Off-Site	Aldrich Junior High School	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Beechmont Recreational Field**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Beechmont Avenue Elementary School**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Christopher Rhodes School	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Cranston General Hospital**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Edgewood High School**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Fay Memorial Field**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Hall Manor Elderly Housing**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Norwood Avenue School**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Park Avenue Elderly Housing**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Park View Junior High School**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Roger Williams Park**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Scandinavian Nursing Home**	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Sprague Playground	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Roberts Circle Residence	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	Pawtuxet Industrial Park	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	CIBA-GEIGY Railroad Right-Of-Way	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	High Ground Along Pawtuxet River	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds
	American Plating Co. (Lawn Area)	Soil	Trowel	Grab	6-12 inches	Appendix IX, Fingerprint Compounds

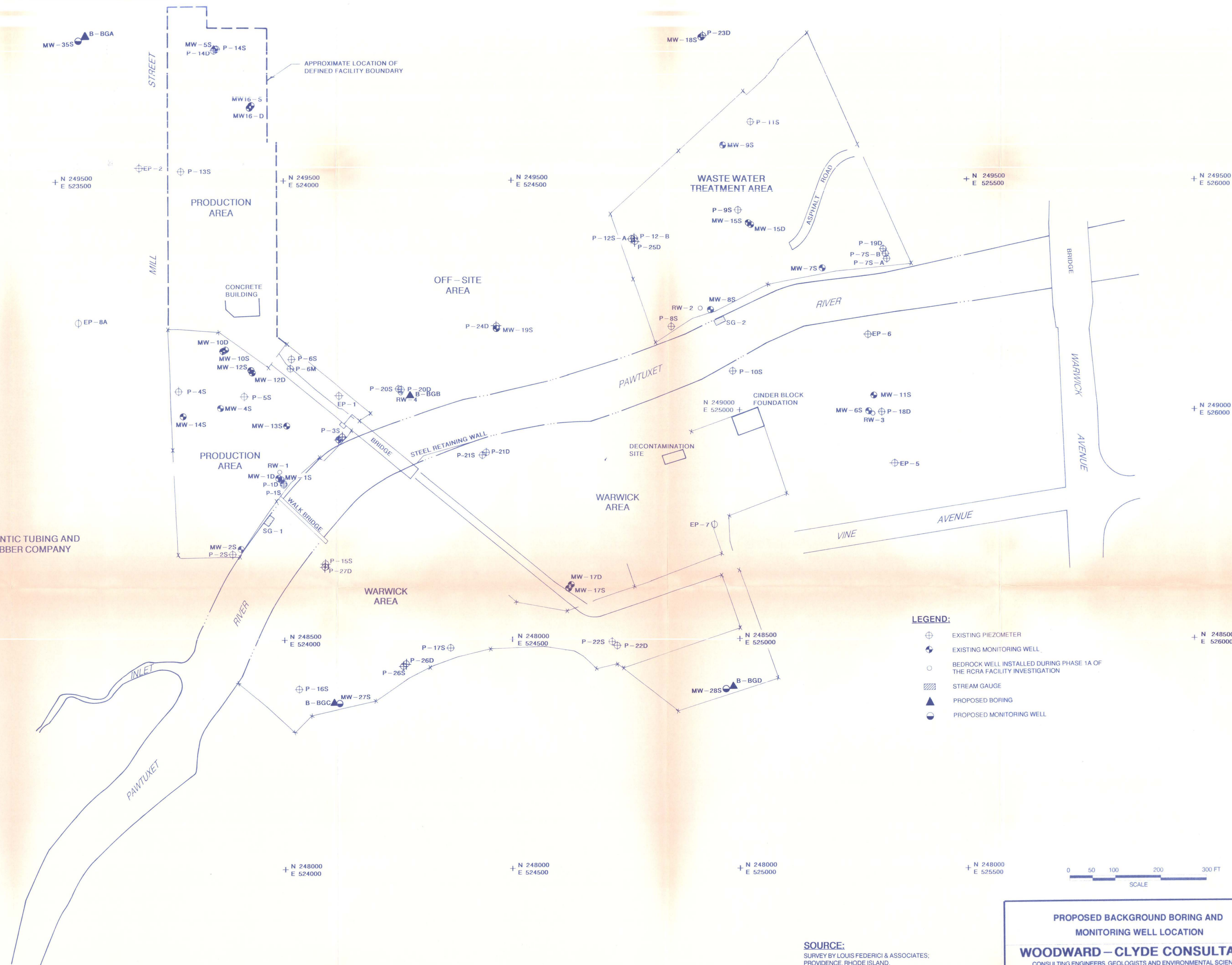
** Locations specified in the Order will be sampled in Round 1 only.

All other additional off-site locations will be sampled in both Round 1 and 2.



EP-8B

ATLANTIC TUBING AND RUBBER COMPANY



LEGEND:

- ⊕ EXISTING PIEZOMETER
- EXISTING MONITORING WELL
- BEDROCK WELL INSTALLED DURING PHASE 1A OF THE RCRA FACILITY INVESTIGATION
- ▨ STREAM GAUGE
- ▲ PROPOSED BORING
- PROPOSED MONITORING WELL

SOURCE:

SURVEY BY LOUIS FEDERICI & ASSOCIATES;
PROVIDENCE, RHODE ISLAND.

PROPOSED BACKGROUND BORING AND MONITORING WELL LOCATION

WOODWARD - CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	KF	SCALE:	1:1200	PROJ. NO.:	87X4660
CK'D BY:	KAK	DATE:	11 OCT 1991	FIG. NO.:	16-1

REVISION NO. 1
21 JULY 1993

17

Warwick Area. The following results were obtained in Phase I for groundwater:

- In the *SWMU-5 overburden* aquifer, VOCs (MTC of 1513 ppb, mostly chlorobenzene) and semi-volatiles [MTC of 50.2 ppb, mostly 4-chloroaniline, 2,2'-oxybis (1-chloropropan), Propazine, and Tinuvin 327] were detected. No PCBs or dioxins/furans were detected. Six pesticides and three herbicides were detected (MTC of 0.25 ppb). Total and dissolved concentrations of both iron and manganese exceeded secondary drinking water standards; total and dissolved concentrations of cadmium exceeded the MCL. Exceptional variations between Rounds 1 and 2 were noted for many treatability indicators and ions. If Round 2 results are representative, treatability parameters would not limit the choice of technologies, except that the water may be slightly corrosive (based on the Langelier Index).
- In the *SWMU-5 bedrock* aquifer, only three semi-volatile organics (MTC of 3 ppb) and one pesticide (0.017 ppb) were detected; none of these were detected in the overburden aquifer. The total concentration of iron exceeded secondary drinking water standards. Exceptional variations between Rounds 1 and 2 were noted for many treatability indicators and ions. If Round 2 results are representative, treatability parameters would not limit the choice of technologies, except that the water may be slightly corrosive (based on the Langelier Index). pH in samples from RW-3 is very high, leading to an encrusting Langelier Index and high calcium and alkalinity. Grout may have entered the gravel pack.
- At *SWMU-16*, only VOCs were detected in the shallow overburden aquifer at a maximum concentration of 40 ppb, mostly due to 1,1,1-trichloroethane. Only toluene (2 ppb) and four pesticides (total concentration of 0.081 ppb) were detected in the deep portion of the aquifer; none of these contaminants were detected in the shallow portion of the overburden aquifer. Total and dissolved concentrations of manganese, and the total concentration of iron, exceeded secondary drinking water standards. Exceptional variations between Rounds 1 and 2 were noted for many treatability indicators and ions. If Round 2 results are representative, treatability parameters would not limit the choice of technologies, except that the water may be slightly corrosive (based on the Langelier Index).

The Phase I results for the study areas indicated groundwater contamination in the Production Area and also possible contamination at localized places in the Warwick Area (as discussed in Chapter 8 and shown in Figures 8-3 and 8-4).

Implications for Treatability Studies

Phase I groundwater analytical results, from some monitoring wells, indicated that selected inorganics (iron and manganese) exceeded the POTW discharge limits. If pilot testing (e.g., aquifer testing) will be conducted, then a discharge permit will need to be obtained prior to discharging pretreated groundwater to the POTW.

Pilot-Scale Pumping/Aquifer Tests. The pilot-scale pumping/aquifer tests in the Production Area (proposed in Chapter 14) are designed to evaluate the hydraulic parameters and boundary conditions in the vicinity of the contaminated groundwater.

Air Stripping Pilot Tests. Recovered groundwater may require pre-treatment before discharge to the local POTW (i.e., the Cranston Wastewater Treatment Plant); the current allocation is 2.13 ppm of total toxic organics (TTO). Some of the groundwater recovered while purging wells prior to sampling exceeded this limitation. Hence, pilot air stripping tests may be run concurrently with aquifer testing to evaluate removal efficiency as the quality of the feed water changes. Samples of influent and effluent will be evaluated for engineering parameters (e.g., iron content, hardness, pH, corrosivity/encrustation potential) during the pumping.

Ultraviolet (UV)-Hydrogen Peroxide Bench Test. Water obtained from the aquifer test also would provide a representative sample for a UV-hydrogen peroxide bench test. The UV-hydrogen peroxide bench test would provide data needed for evaluating the destruction efficiency and scale-up, as well as the projected capital and operating cost, of a full-scale treatment system. Various detention times, peroxide concentrations, and light intensities would be tested. The need for further treatment (such as activated carbon polishing) also would be evaluated.

Adsorption/PACT™ Bench Test. Water obtained from the aquifer test also would provide a representative sample for an adsorption/PACT bench test. (PACT — powdered activated carbon treatment — is a proprietary technology.) The adsorption/PACT bench test would provide data needed for evaluating the removal efficiency and scale-up, as well as the projected capital and operating cost, of a full-scale treatment system. Various detention times and carbon additions would be tested.

Surface Water (SWMU-10 Pond)

In Phase I, surface water was investigated in the Waste Water Treatment Area (SWMU-10) pond. The analytical results were discussed in Chapter 7. Table 17-4 presents the results for treatability parameters in surface water samples from the SWMU-10 pond.

The VOC 2-hexanone (7 ppb) and three organochlorine pesticides (total concentration of 0.11 ppb) were the only compounds detected in the SWMU-10 pond surface water. The total concentration of iron exceeded secondary drinking water standards. COD appears high in Round 1 relative to the BOD and the TOC values. Round 2 results are more consistent and are not abnormal.

Sediment (SWMU-10 Pond)

In Phase I, sediment also was investigated in the SWMU-10 pond. The analytical results were discussed in Chapter 7. Table 17-5 presents the results for treatability parameters in sediment samples from the pond.

VOCs (MTC of 0.12 ppm), semi-volatile organics (MTC of 9 ppm, mostly di- and trichlorodibenzofurans), and pesticides/herbicides (MTC of 0.066 ppm) were detected in the SWMU-10 pond sediment. Calcium, sodium, and zinc exceeded the background soil baselines. The results of treatability parameters for pond sediments would not limit the choice of technologies if treatment were necessary.

17.3.2 Off-Site: Pawtuxet River

The Phase I results, and their implications for corrective measures, are discussed here for the Pawtuxet River Media of Concern — surface water and riverbed sediment.

Surface Water

In Phase I, surface water was investigated in all three reaches of the river (upstream, facility, and downstream). The analytical results for river surface water were discussed in Chapter 9. Table 17-6 presents the results for treatability parameters in surface water samples from the river. (Physicochemical data for the Pawtuxet River also are presented in Appendix Z.)

Phase I Results

The following results were obtained in Phase I for Pawtuxet River surface water:

solvent). The liquid dissolves the contaminants in the soil; the liquid is then separated and treated to remove the dissolved contaminants. For heavy metals, a dilute acid is used to dissolve the metals; the dilute acid is then separated from the soil and is neutralized with Alkali to precipitate the metals as hydroxides. The precipitate is then removed by filtration. For volatile organics, the solvent used to extract the organics is recovered by distillation; the washed soil is then dried and either replaced or disposed off-site. Although this technology is more costly than other equally effective methods for reducing the primary contaminants (e.g., VOCs) at this site, this technology is *retained* for further evaluation.

Biological Treatment

In biological treatment (sometimes called “bioremediation”), water containing nutrients and hydrogen peroxide is circulated through the soil to promote biodegradation of the contaminants. Bioremediation can be performed in-situ if 1) sufficient natural bacteria exist at (or are added to) the site, and 2) bioreactory chemicals and elevated levels of toxic heavy metals are not present in the soil. Bioremediation can be performed ex-situ by tilling to aerate and turn the soil; this is called “landtreatment”. Although bioremediation would not remove heavy metals, this technology is *retained* for further evaluation because it may be effective in removing organic constituents from the soils.

Thermal Treatment

In thermal treatment (also known as “thermal processing” or “thermal destruction”), the contaminated soil is excavated and fed to a rotating thermal device such as a rotary kiln. The soil is heated (directly or indirectly) to a temperature of 300° to 500°F for low-temperature treatment, or directly to about 1200°F for high-temperature treatment. Low-temperature treatment volatilizes all or most of the volatile organics; the vapors are then incinerated in an afterburner, and the residue is water- scrubbed. High-temperature treatment incinerates all the organics in the kiln. The effluent gases are quenched and scrubbed to remove dust and acids. Either treatment method can be used on-site or off-site. Although thermal treatment would not remove heavy metals and is energy-intensive, this technology is *retained* for further evaluation.

17.4.2 Groundwater Remediation Technologies

Table 17-9 lists the technologies considered for any necessary on-site groundwater remediation. Ten of these technologies were considered in greater detail because they might require collecting additional data or conducting pilot/bench tests:

- containment;
- air stripping;
- steam stripping;
- granular activated carbon (GAC) adsorption;
- resin adsorption;
- PACT;
- chemical/electrical precipitation;
- wet-air oxidation;
- ultraviolet (UV)-enhanced hydrogen peroxide/ozone oxidation;
- biological treatment.

These ten groundwater remediation technologies are discussed briefly here.

- a *UV-hydrogen peroxide bench test* (on groundwater in the Production Area); and
- an *adsorption/PACT bench test* (on groundwater in the Production Area).

Of the potential soil remediation technologies considered, eight technologies were evaluated in detail:

- *capping* — retained for further consideration;
- *chemical fixation* — retained for further consideration;
- *solidification/stabilization* — retained for further consideration;
- *encapsulation/vitrification* — not retained for further consideration;
- *vapor extraction* — retained for further consideration;
- *water/solvent leaching* — retained for further consideration;
- *biological treatment* — retained for further consideration; and
- *thermal treatment* — retained for further consideration.

Of the potential groundwater remediation technologies considered, ten technologies were evaluated in detail:

- *containment* — retained for further consideration;
- *air stripping* — retained for further consideration;
- *steam stripping* — retained for further consideration;
- *GAC adsorption* — retained for further consideration;
- *resin adsorption* — retained for further consideration;
- *PACT* — retained for further consideration;
- *chemical/electrical precipitation* — retained for further consideration;
- *wet-air oxidation* — retained for further consideration;
- *UV-enhanced hydrogen peroxide/ozone oxidation* — retained for further consideration; and
- *biological treatment* — retained for further consideration.

Of the potential sediment remediation technologies considered, three technologies were evaluated in detail:

- *capping* — retained for further consideration;
- *dredging and treatment/disposal* — retained for further consideration; and
- *diversion, excavation, and treatment/disposal* — retained for further consideration.

The technologies that have been retained will be evaluated again for possible inclusion in the CMS Proposal.

B

Table B-7. Data Qualifiers for Validated Data

<u>Qualifier</u>	<u>Description</u>
C	Result is confirmed on the second column or by GC/MS
D	Dilution of the sample was necessary to analyze for this compound
J	Analyte was detected at a concentration below the detection limit
NA	Not analyzed; "NA" replaces the numerical value in the RESULTS field
N\	Not available; "N\" replaces the numerical value in the RESULTS field
N\A	Sample was not available; "N\A" replaces the numerical value in the RESULTS field
NC	Not calculated; "NC" replaces the numerical value in the RESULTS field
ND	Not detected at the specific detection limit
NR	Analysis not requested
NS	Sample was not spiked; "NS" replaces the numerical value in the RESULTS field
R	Data are unusable; the compound may or may not be usable
S	Result was determined by the method of standard addition
U	Analyte not detected at the specific detection limit

Table B-8. Data Qualifiers for Final Data

<u>Qualifier</u>	<u>Description</u>
J	Analyte was detected at a concentration below the detection limit
NA	Not analyzed; "NA" replaces the numerical value in the RESULTS field
N\	Not available; "N\" replaces the numerical value in the RESULTS field
N/A	Sample was not available; "N/A" replaces the numerical value in the RESULTS field
NC	Not calculated; "NC" replaces the numerical value in the RESULTS field
NR	Analyte was not requested; "NR" replaces the numerical value in the RESULTS field
NS	Sample was not spiked; "NS" replaces the numerical value in the RESULTS field
R	Analyte was detected in the blank sample; the result has been corrected
U	Analyte was undetected
U2	Inorganic analyte was undetected; required by USEPA

Table B-9. Transfer Rules for Final Data

If the Validated Data Qualifier = ... then the Final Data Qualifier = ... and FINAL DATA =

R ¹	R	(blank)
N\	N\	(blank)
N\A	N\A	(blank)
NA	NA	(blank)
NC	NC	(blank)
ND	U	Detection Limit
NR	NR	(blank)
NS	NS	(blank)
J	J	Validated Data
(blank)	(blank)	Validated Data
S	(blank)	Validated Data
C	(blank)	Validated Data
D	(blank)	Validated Data
U	U	Detection Limit

NOTE:

1. Data qualifiers are defined in Tables B-2, B-7, and B-8.

BB

BB

**ADDENDUM TO THE PHASE I INTERIM REPORT
AND PHASE II PROPOSAL**

BB.1 OVERVIEW

In a letter dated 15 June 1993, USEPA granted approval of the Phase I Interim Report and the Phase II Proposal for the former CIBA-GEIGY facility in Cranston, Rhode Island, conditional on addressing the comments in that letter. This appendix (addendum) addresses Comments 2, 3, 12, 14, 15, 28, and 29 -- the comments concerned with the possible downward migration of constituents from the shallow overburden.

The data from the Phase I and stabilization investigations indicate little or no migration of shallow groundwater contamination to the deep overburden groundwater and the bedrock aquifer, and support our proposal not to conduct additional investigations in the deep overburden and bedrock. These data include an evaluation of the site's stratigraphy and vertical hydraulic gradients, as well as an evaluation of the analytical results of groundwater sampled from selected wells.

The low permeability Silt and Till units are the main stratigraphic properties restricting the downward migration of constituents. The predominant upward vertical hydraulic gradient is the most important hydrogeologic property restricting the downward migration of constituents. Section BB.2 presents a detailed explanation of how these stratigraphic and hydrogeologic properties affect constituent migration. Section BB.3 presents a summary of the groundwater analytical results to support the conclusion that constituents are not migrating to the deep overburden groundwater and bedrock aquifer. Finally, Section BB.4 presents detailed individual responses to Comments 2, 3, 12, 14, 15, 28, and 29 (hereafter, simply called "the USEPA comments").

**BB.2 STRATIGRAPHIC AND HYDROGEOLOGIC FACTORS AFFECTING
CONSTITUENT MIGRATION**

This section discusses how the stratigraphic and hydrogeologic properties of the site (i.e., the Silt unit, the Till unit, and the upward vertical hydraulic gradients) restrict the

migration of constituents to the deep overburden groundwater and the bedrock aquifer.

BB.2.1 Silt Unit

The Silt unit underlies all areas of the site with two exceptions: 1) in the Production Area where the Gravelly Sand unit is located (Figure 2-2 of the Stabilization Investigation Report), and 2) off-site at the well cluster location P-20S/D and RW-4. The Silt unit is up to 38 feet thick in some areas of the site and, where present, occurs between the shallow and deep overburden.

The Silt unit restricts the downward migration of constituents in the shallow overburden in two ways. First, the Silt unit has a lower permeability than the overlying shallow overburden and the underlying deep overburden, thus reducing the potential for constituents to migrate through it. Second, the Silt unit acts to semi-confine the underlying deep overburden. The semi-confining pressure caused by the overlying Silt unit results in higher piezometric pressure in the deep overburden, which results in an upward vertical hydraulic gradient between the shallow and deep overburden. (Vertical hydraulic gradients are discussed in more detail in Section BB.2.3.)

BB.2.2 Till Unit

The Till unit was found in each deep site boring with the exception of the borings advanced for the following well clusters: MW-6S/P-18D/RW-3, MW-17S/D, P-22S/D, and MW-19S/P-24D. The Till unit lies between the deep overburden and the bedrock aquifer.

The Till unit restricts the downward migration of constituents in two ways. First, the Till unit has a lower permeability than the overlying deep overburden, thus reducing the potential for constituents to migrate through it. Second, the Till unit generally acts to confine or semi-confine the underlying bedrock aquifer. The confining/semi-confining pressure caused by the overlying Till unit results in higher piezometric pressure in the bedrock aquifer, which results in an upward vertical hydraulic gradient between the deep overburden and bedrock aquifer. (Vertical hydraulic gradients are discussed in more detail in section BB.2.3.)

BB.2.3 Upward Vertical Hydraulic Gradients

An upward vertical hydraulic gradient will restrict the downward migration of constituents from the shallow overburden to the deep overburden groundwater and the bedrock aquifer. Vertical hydraulic gradients were determined by making two types of comparisons -- by comparing the water level elevations 1) between the shallow and deep overburden wells at a well cluster, and 2) between the deep overburden wells and bedrock wells at a well cluster. Vertical hydraulic gradients were determined at selected well clusters using the data from the fourteen water level measurement rounds presented in Table 4-4 of the Phase I Interim Report. These vertical gradients are presented on Table BB-1 along with the direction (upward or downward) of the gradient (i.e., the direction that groundwater will flow). The wells used for this evaluation were selected to represent each of the different site areas, and include each of the well clusters identified in the USEPA comments.

The vertical gradients presented in Table BB-1 are predominately upward, indicating that constituents in the shallow overburden are not migrating downward into the deep overburden or bedrock aquifers. In general, these upward vertical gradients are consistent in each of the water level measurement rounds. Upward vertical gradients varied from about 0.02 to 4.12 feet/foot. Downward vertical gradients were present consistently in only two well clusters (MW-1S/D and MW-19S/P-24D) and ranged from 0.03 to 0.50 feet/foot.

In summary, at each of the well clusters identified in the USEPA comments, there exists either 1) a consistently upward vertical hydraulic gradient, or 2) a low permeability Silt and/or Till unit to restrict the downward migration of constituents from the shallow overburden to the deep overburden groundwater or to the bedrock aquifer. The analytical results of groundwater sampled from these well clusters support the conclusions that constituents are not migrating downward. These analytical results are summarized next.

BB.3 SUMMARY OF GROUNDWATER ANALYTICAL DATA

The groundwater analytical results support the hydrogeologic conclusions that constituents are not migrating to the deep overburden groundwater and bedrock aquifer. The total volatile organic compound (VOC) and semi-volatile organic compound (semi-volatile) concentrations from the three groundwater sampling rounds (Rounds 1 and 2 were presented in the Phase I Interim Report; Round 3 was summarized in the March 1992 Monthly Progress Report) were used in this evaluation. These data are summarized in Table BB-2.

The detection limits of the constituents reported in the three groundwater sampling rounds were within the laboratory contract requirements for all wells with the exception of the most contaminated wells in the Production Area (MW-1S, MW-2S, MW-4S, MW-12S, and MW-14S). Thus, although high detection limits can affect whether a constituent at a low concentration is detected (or whether it truly is not detected), the detection limits are not a factor in evaluating the results of the deep overburden or bedrock groundwater samples (because the high detection limits occurred only in the shallow overburden wells).

In general, the groundwater analytical results shown in Table BB-2 indicate that little or no migration of constituents is occurring from the shallow overburden to the deep overburden groundwater or to the bedrock aquifer. Significantly lower (or no) detections of VOCs or semi-volatiles were reported in the deep overburden or bedrock monitoring well samples. The details of these analytical results are discussed next in the specific responses to the individual USEPA comments.

BB.4 SUMMARY AND SPECIFIC RESPONSES TO COMMENTS

This section summarizes how the data support our position not to conduct additional investigations in the deep overburden groundwater and the bedrock aquifer. It also presents specific responses to each of the USEPA comments.

BB.4.1 Summary

Evaluation of the site's stratigraphy, vertical hydraulic gradients, and groundwater analytical results indicate little potential for contamination of the deep overburden groundwater and the bedrock aquifer from historic site activities. The following points support this position:

- The Silt unit, the Till unit, and the predominant upward vertical hydraulic gradient all act to restrict the downward migration of constituents from the shallow overburden to the deep overburden groundwater or the bedrock aquifer. While these three stratigraphic/hydrogeologic factors work in combination, each factor independently restricts the migration of constituents downward. This is important since all three of these factors are not present everywhere at the site. The Silt and Till units are discontinuous, and there are locations where the vertical gradient is downward. However, one or more of these factors exists at each well location.
- The Silt unit, present in most areas of the site, has a lower permeability than both the overlying shallow overburden and the underlying deep overburden. The Silt unit semi-confines the deep overburden, which generally results in an upward vertical hydraulic gradient in that unit.
- The Till unit, also present in most areas of the site, generally has a lower permeability than the underlying bedrock. The Till unit confines or semi-confines the bedrock aquifer, which results in an upward vertical hydraulic gradient.
- Upward vertical hydraulic gradients are present in most well clusters. A slight downward gradient is present in the SWMU-5 area (at wells MW-6S/P-18D/RW-3) and off-site (at wells MW-19S/P-24D). In these areas, however, the Silt unit restricts the downward migration of shallow overburden constituents.

- The groundwater analytical results support the stratigraphic and hydrogeologic conclusions that constituents detected in the shallow overburden are not migrating into the deep overburden or the bedrock. Samples collected from each of the deep overburden and bedrock monitoring wells show either trace levels or no detections of constituents.

BB.4.2 Specific Responses to USEPA Comments

The data summarized in this addendum show that there is no need to conduct additional investigations evaluating the deep overburden groundwater and the bedrock aquifer. The specific responses to each of the USEPA comments are presented here.

Comment 2, Page 4-6: *The discussion of the till states that it appears to act as an aquitard, however, because the till is discontinuous there is some potential for good hydraulic connection between the two aquifers where the till is absent. There should be more discussion on the areas where the till is absent and whether these areas are a concern due to possible migration of overburden aquifer contaminants.*

Response to Comment 2: The relevant site stratigraphy was summarized in Section BB.2. (More comprehensive discussions were presented in the Phase I Interim Report and in the Stabilization Investigation Report and Design Concepts Proposal.) The Till unit is absent at three well clusters (MW-6S/MW-11S/P-18D/RW-3, MW-17S/17D, and P-22S/22D) in the Warwick Area. Where the Till unit is absent, the low permeability Silt unit is present at thicknesses of about 32 to 38 feet. In addition, a predominant upward vertical gradient is present at these locations. Collectively, these data indicate that there is little or no potential for downward migration of contaminants into the deep overburden and bedrock aquifer at these locations. The groundwater analytical results support this conclusion. In the shallow overburden aquifer (at MW-6S, MW-11S, and MW-17S), either constituents were not detected, or were detected at only trace concentrations (2 ppb of total VOCs in one sample from MW-17D, and 0.7 to 4 ppb of total semi-volatiles in RW-3 and MW-17D), in the three groundwater sampling rounds.

Comment 3, Fig. 4-7 & Table 4-4: *Chapter 4 states that there is little or no potential for the bedrock aquifer to become contaminated because an upward gradient exists. However, a slight downward gradient appears to exist at well cluster MW-11S, MW-6S, P-18D, and RW-3 all in the SWMU 5 area. There should be a more thorough discussion of the characteristics and the relationship between the aquifers and the gradients.*

Response to Comment 3: A strong vertical upward gradient exists between the shallow overburden and the deep overburden aquifers at SWMU-5. Groundwater elevations measured at MW-6S and P-18D indicate an upward vertical hydraulic gradient greater than 3 feet in 10 consecutive measurements (Table BB-1). This upward gradient is attributable to the Silt unit that separates the shallow and deep overburden groundwater at this location.

Although a slight downward gradient does exist between MW-18D and RW-3 because the Till unit is not present at this location, migration of constituents from the shallow overburden to the bedrock is restricted by the low permeability Silt unit (which is about 38 feet thick in this area).

Three rounds of groundwater samples have been collected from the monitoring wells at SWMU-5. Constituents detected in the shallow overburden groundwater decreased significantly with depth. As stated in the response to Comment 2, VOCs detected in shallow monitoring wells MW-6S and MW-11S were not detected in the bedrock well RW-3. Semi-volatile compounds were detected only at trace levels in RW-3.

Comment 12, Page 6-28: *A more thorough discussion should be given on why additional sampling of Bedrock well RW-1 will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.*

Response to Comment 12: Additional sampling of RW-1 is not proposed because the data indicate that there is no vertical migration of constituents into the bedrock at this location. At RW-1, the Silt unit restricts the downward migration of constituents from

the overlying Fill unit into the underlying Fine Sand unit. The Silt unit is about five feet thick at RW-1.

The Till unit is about 12 feet thick at RW-1. The upward vertical hydraulic gradient between the deep overburden groundwater and the bedrock aquifer (at MW-1D/RW-1) also restricts the downward migration of constituents into the bedrock aquifer. A slight upward vertical gradient between MW-1D and RW-1 (from 0.02 to 0.58) has been measured on 11 occasions (Table BB-1).

The analytical results from the three rounds of groundwater sampling at MW-1S, MW-1D, and RW-1 also support the conclusion that downward vertical migration of constituents is not occurring. In MW-1S, VOCs were detected at concentrations up to 23,400 ppb and semi-volatiles were detected at concentrations up to 305 ppb. In MW-1D, total VOC and semi-volatile concentrations were 9 ppb and 120 ppb in one sampling round; in the other two sampling rounds, VOCs and semi-volatiles were not detected. This significant difference in constituent levels clearly indicates that the Silt unit restricts the downward migration of constituents at this location. Thus, the results for the three samples collected from RW-1 support the conclusion that constituents are not entering the bedrock aquifer here. Only trace levels of constituents (2 ppb of VOCs and 3 ppb of semi-volatiles) were reported in the three samples collected from RW-1. Also, as discussed in Section BB.3, detection limits are not a factor in evaluating the presence or levels of constituents reported in the deep overburden or bedrock groundwater samples.

Comment 14, Page 7-13 & 14: *A more thorough discussion should be given on why additional sampling of wells RW-2 and MW-15D will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.*

Response to Comment 14: Additional sampling of wells RW-2 and MW-15D is not proposed because the Silt and Till units and the upward vertical hydraulic gradients all restrict the downward migration of constituents into the deep overburden groundwater and bedrock aquifer. The Silt unit in the Waste Water Treatment Area is consistently

found at each well cluster location at thicknesses of 12 to 27 feet. (At MW-15D it is 20 feet thick and at RW-2 it is 25 feet thick.) The low permeability of the Silt unit restricts the downward movement of constituents into the deep overburden groundwater. The Till unit, about 5 feet thick at RW-2, restricts the downward migration of constituents from the deep overburden groundwater to the bedrock aquifer. In addition, there is a strong upward gradient (4.00 to 5.59 feet/foot) between MW-8S and RW-2. Thus, the data indicate that there is no mechanism for contamination to enter the deeper groundwater here, so there is no need to re-sample the groundwater at MW-15D and RW-2.

The groundwater analytical results also support the conclusion that downward vertical migration is not occurring. Only trace levels of VOCs (4.2 ppb total in one of three sampling rounds) were detected in MW-15D, and no VOCs were detected in the three samples from RW-2. Semi-volatiles were present only at trace levels in these two wells. In MW-15D, semi-volatiles were detected at total concentrations of 42 and 130 ppb in the first two sampling rounds; in the third round, semi-volatiles were not detected. In RW-2, semi-volatiles were detected only in one of the three sampling rounds at a total concentration of 37 ppb. Also, as discussed in Section BB.3, detection limits are not a factor in evaluating the presence or levels of constituents reported in the deep overburden or bedrock groundwater samples.

Comment 15, Page 8-8 & 17: *A more thorough discussion should be given on why additional sampling of wells RW-3 and MW-17D will not be performed in Phase II. The discussion should include the adequacy of existing data based on detection limits and analytes detected, relationship of contamination with depth, and evaluation of the stratigraphy and hydraulic gradients.*

Response to Comment 15: Additional sampling of wells RW-3 and MW-17D is not proposed because the Silt unit and the upward vertical hydraulic gradients restrict the downward migration of constituents into the deep overburden groundwater and bedrock aquifer. The Silt unit in the Warwick Area is consistently found at each well cluster location at thicknesses of 32 to 38 feet. (At MW-17D it is 36 feet thick and at RW-3 it is 38 feet thick.) The low permeability of the Silt unit restricts the downward movement of constituents into the deep overburden groundwater. The strong upward gradient (1.63

to 2.60 feet/foot) between MW-17S and MW-17D also restricts the downward migration of constituents from the shallow overburden to the deep overburden groundwater. Thus, the data indicate that there is no mechanism for contamination to enter the deeper groundwater here, so there is no need to re-sample the groundwater at MW-17D and RW-3.

The groundwater analytical results also support the conclusion that downward vertical migration is not occurring. Only trace levels of VOCs (2 ppb total in one of three sampling rounds) were detected in MW-17D, and no VOCs were detected in the three samples from RW-3. Semi-volatiles were present only at trace levels in these two wells. In MW-17D, semi-volatiles were detected at a total concentration of 0.7 ppb in one of three sampling rounds. In RW-3, semi-volatiles were detected in two of the three sampling rounds at total concentrations of 4 and 2 ppb. Also, as discussed in Section BB.3, detection limits are not a factor in evaluating the presence or levels of constituents reported in the deep overburden or bedrock groundwater samples.

Comment 28, Chapter 14: *There needs to be more discussion on why a deep well will not be needed in the southern portion of the WWT Area at the proposed location of MW-25S.*

Response to Comment 28: As discussed in the response to Comment 14, the Silt unit is present throughout the Waste Water Treatment Area at a thickness of about 12 to 27 feet. The Till unit also is found in most of the Waste Water Treatment Area, with the exception of the southeastern corner of the site (by the bedrock high at P-19D), at a thickness of up to 5 feet. There also are strong upward gradients present between MW-15S and MW-15D, P-7S and P-19D, MW-18S and RW-2, and P-12S and P-25D. Thus, the data (the presence of the Silt and Till units, together with the consistent upward vertical hydraulic gradients) indicate that there is no mechanism for constituents from the shallow overburden to migrate downward into the deeper overburden, so there is no need to construct an additional deep well in the southern portion of the Waste Water Treatment Area.

The groundwater analytical results from the three sampling rounds of the two deep wells in the Waste Water Treatment Area (MW-15D and RW-2) support this conclusion.

(Details about the constituents detected in these wells were provided in the response to Comment 14.)

Comment 29, Chapter 15: *There needs to be more discussion on the rationale for excluding sampling the deep ground water at SWMU-10 and SWMU-12.*

Response to Comment 29: SWMU-10 and SWMU-12 are located in the northern and central portion of the Waste Water Treatment Area. At these locations, the Silt unit is present at thicknesses of more than 20 feet. A consistent strong upward vertical hydraulic gradient also is present in the wells in this area. As discussed in the responses to Comments 14 and 28, the Silt unit and the upward gradients in the Waste Water Treatment Area effectively restrict the migration of constituents from the shallow overburden groundwater to the deep overburden groundwater and bedrock aquifer, so there is no mechanism for constituents from the shallow overburden to migrate downward into the deeper overburden. Thus there is no need to sample deep groundwater at SWMU-10 and SWMU-12.

The groundwater analytical results from the three sampling rounds of the two deep wells in the Waste Water Treatment Area (MW-15D and RW-2) support this conclusion. (Details about the constituents detected in these wells were provided in the response to Comment 14.)

Overall, the data from the Phase I and stabilization investigations indicate little or no potential for constituents in the shallow groundwater to migrate downward to the deep overburden groundwater and the bedrock aquifer. The data from these investigations support our proposal not to conduct additional investigations in the deep overburden groundwater and the bedrock aquifer.

Table BB-1. Vertical Hydraulic Gradients Between Selected Wells

	9/13/90	10/25/90	11/27/90	12/5/90	1/7/91	1/16/91	2/19/91	3/12/91	3/21/91	4/15/91	4/24/91	5/15/91	6/25/91	7/22/91
MW-1S/1D	NA	NA	0.07 D	NA	0.07 D	0.04 D	0.07 D	0.17 D	NA	NA	0.22 D	0.50 D	NA	0.03 D
MW-1D/RW-1	0.02 U	0.09 U	0.16 U	0.08 U	0.20 U	0.15 U	0.27 U	0.27 U	NA	NA	0.14 U	0.58 U	NA	0.39 U
MW-8S/RW-2	NA	4.13 U	4.45 U	NA	4.00 U	4.95 U	5.08 U	4.88 U	4.46 U	5.59 U	4.86 U	5.55 U	5.14 U	4.98 U
MW-6S/P-18D	NA	0.87 D	0.25 U	0.51 D	3.39 U	3.50 U	3.55 U	3.86 U	3.54 U	4.01 U	3.56 U	4.08 U	3.97 U	3.89 U
P-18D/RW-3	NA	4.12 U	3.10 U	3.11 U	0.08 D	NA	0.20 D	0.16 D	0.32 D	0.08 D	NA	NA	0.14 D	0.06 D
MW-17S/17D	NA	NA	NA	NA	1.98 U	1.78 U	1.86 U	1.77 U	1.63 U	2.20 U	1.99 U	2.12 U	2.56 U	2.60 U
P-22S/22D	1.97 U	1.58 U	0.80 U	1.35 U	1.08 U	0.95 U	0.98 U	0.50 U	0.83 U	1.33 U	1.17 U	1.34 U	1.78 U	1.85 U
P-20S/20D	0.64 U	0.67 U	0.32 U	0.06 D	0.05 U	0.49 U	0.02 U	0.10 U	0.10 U	0.09 D	0.12 U	0.02 D	0.30 U	0.14 U
P-20D/RW-4	1.22 D	0.88 D	1.20 D	0.35 U	0.13 D	0.23 D	0.02 U	0.12 U	0.27 U	0.10 U	0.30 U	0.01 U	0.01 D	0.03 D
MW-19S/P-24D	NA	NA	NA	NA	0.03 D	0.05 D	0.03 D	0.11 D	0.13 D	0.15 D	0.09 D	0.11 D	0.04 U	NA

Notes: A vertical hydraulic gradient exists when there is a difference in hydraulic head measured in wells in different formations or at different depths in the same formation. The direction of groundwater movement is upward if the deeper well has a higher head than the shallow well and downward when the opposite condition applies.

All measurements are in Feet MSL

D=Downward

U=Upward

NA=Data not available

Prepared by: JDV

Checked by: TRP

TABLE BB-2. SUMMARY OF ORGANIC CONSTITUENTS DETECTED IN MONITORING WELL SAMPLES

	TOTAL VOLATILE ORGANIC COMPOUNDS			TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS		
	Jan-91	Apr-91	Dec-91	Jan-91	Apr-91	Dec-91
PRODUCTION AREA						
RW-1	1	2	ND	3	ND	ND
MW-10S	ND	ND	ND	ND	ND	ND
MW-10D	ND	2.2	1.8	ND	ND	ND
MW-12S	5020	2916	11,249	1158	72	19
MW-12D	216	56	62	38	17	25
MW-1S	11608	23400	18340	305	113	140
MW-1D	ND	9	ND	120	ND	ND
WASTEWATER TREATMENT AREA						
MW-7S	ND	ND	ND	17	ND	ND
MW-8S	3	4.1	ND	13	18.4	ND
MW-9S	4.6	5.5	NA	18	ND	NA
MW-15S	84	33	NA	1106	539	NA
MW-15D	4.2	ND	ND	42	130	ND
RW-2	ND	ND	ND	ND	37	ND
WARWICK AREA						
MW-6S	1.8	1.1	ND	38	15	16.7
MW-11S	3584	797	390	89	20	7.9
RW-3	ND	ND	ND	4	2	ND
MW-17S	40	24	2.9	ND	ND	ND
MW-17D	2	ND	ND	ND	ND	0.7
OFF-SITE						
MW-19S	ND	ND	2.1	7	ND	ND
RW-4	ND	ND	ND	ND	ND	ND

Notes:

All concentrations reported in ppb.

ND = Not Detected

NA = Not Analyzed

Prepared by: JDV

Checked by: TRP